Engineering News-Record

Twenty-five cents, five dollars per year **January 11, 1934** McGraw-Hill Publishing Company, Inc.

SAFE HARBOR HYDRO PLANT ON THE SUSQUEHANNA

Significant progress in the design of hydraulic and structural elements of hydro-electric power plants is recorded in the new Safe Harbor development near Columbia, Pa. A total length of dam of nearly 5,000 ft., of which about 1,000 ft. is occupied by the power house, and five generator units of 42,500 hp. each at 55 ft. head are elements of the project that portray an idea of its size. An article in this issue describes such details as the dam, spillway, control gates, special skimmer wall intake, power house and generating equipment.

WORK-RELIEF OPERATIONS UNDER THE CWA

The institution of the Civil Works Administration with its work-relief provisions brought new and difficult problems to nearly every community in the country. A maximum of useful jobs had to be provided quickly. An organization had to be set up. Operating technique had to be developed. What kind of jobs were found? How has CWA work been organized and carried on? An editorial survey of representative cities in every part of the country, undertaken to answer these questions, is presented in this issue.

ALSO IN THIS ISSUE:

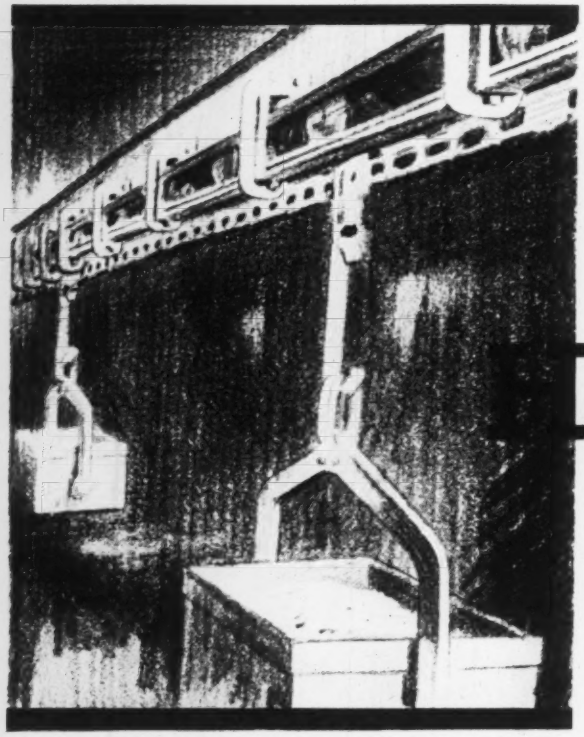
Slender Concrete-Arch Bridges in Switzerland

Determining Silt Content in Aggregates

Winter Paving in Troy, Ohio

New Type of Composite Timber-Concrete Beam

Los Angeles County Flood Report



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IN THE NEWS:

DURING the past week the Public Works Administration gave its approval to more than 550 non-federal projects, five times the maximum of any previous week. Some projects should have been approved weeks ago. Why so many were held back when the PWA said so much about its efforts to get such projects under way is not clear. Of course, the long lists will make good reading for Congressmen.

THE CONSTRUCTION CODE still awaits action. It is more than two weeks now since General Johnson signed the code and passed it to the President for approval. After holding it for some days and keeping everyone concerned in a state of suspense, the President stated that he would not approve it until he had given the opposition a chance to be heard—which means the A. F. of L.

BY SUBMITTING a budget that includes no further appropriations for public works during the remainder of the current fiscal year President Roosevelt has put himself in the very comfortable position of having Congress force money on him at the same time he exhibits proper concern with respect to the mounting public debt. On the sidelines is Secretary Ickes, continuing to run his public works program as if unlimited funds were still at his disposal, and egging Congress on by announcing to the country that project applications will continue to be received, in the hope more funds will be appropriated.

IN THIS ISSUE:

ABOVE THE Conowingo and the Holtwood hydro-electric power plants on the Susquehanna River in Pennsylvania is the plant of the Safe Harbor Water Power Corp. An article by Paul E. Gisiger, structural engineer in charge of building the work, makes an important addition to hydro-plant literature.

AN UNUSUALLY HEAVY RAINFALL occurred in and around Los Angeles between Dec. 30 and Jan. 1, as everyone knows who heard the radio report of the Rose Bowl football game in Pasadena on New Year's Day. The radio announcer hardly did the storm justice, however, since in many respects it was of unprecedented severity, and it was unusually destructive. E. C. Eaton, chief engineer, Los Angeles County Flood-Control District reports that fire-stripped hill-sides offered little resistance to runoff from a rain with a maximum intensity of 1 in. per hour, and debris flows proved disastrous to the valleys below.

IN SWITZERLAND an interesting type of concrete-arch bridge is used that has no counterpart in this country. The design attempts to eliminate all interaction between rib and deck by using slender columns and a particularly rigid deck girder. The arch rib is then designed with an unusually thin section to take only direct thrust.

ANOTHER AND reputedly better design for composite timber-and-concrete beams has been developed by the engineers of the American Wood Preservers' Association. Composite construction, in which timber is used on the tension side and concrete on the compression side, has been most vulnerable in horizontal shear along the separation plane. Dowel nails have been largely used, acting as short cantilevers to resist the shear. The new design substitutes triangular plates for the nails and supports them on three sides by an ingenious arrangement of the timber.

UNEMPLOYMENT RELIEF under the recently formed Civil Works Administration has been widely heralded. Inquiring editors on a 2,000-mile trip found the CWA a success as an emergency unemployment-relief measure. They saw useful work being done and worker morale lifted far above the old breadline blues.

COMING ARTICLES:

CONSOLIDATION of the railroad stations south of the Loop district in Chicago in a new station on the lakefront is proposed by the city council's railway terminals committee. An illustrated abstract of the committee's report will be published in the Jan. 25 issue.

NEXT WEEK, the entire issue will be devoted to roadbuilding. This annual highway issue is timed to appear just prior to the convention of the American Road Builders Association in Chicago. This year its purpose is to focus attention on facts bearing on the work done under $600,000,000 federal appropriation for emergency roadbuilding and on the future of highway construction.

VISITORS approaching two of the lock-building jobs on the upper Mississippi below St. Paul during the past few months may have thought that dredging operations were going on, for pipe lines ran in every direction. Actually, the pipes, instead of carrying material away from the job, as in dredging work, were supplying material to the job. And the material was concrete, which was being pumped for the first time—at least on a large scale. The use of the new concrete pump, in appearance and also in general design resembling the familiar duplex water pump, created an entirely new construction scene. It also created new problems and new economies. An article in the Jan. 25 issue will tell how "Pumped Concrete Builds Mississippi Locks."

Index of Volume 111

AN INDEX for Volume 111 of *Engineering News-Record*, July to December, 1933, will be published in connection with the Jan. 25 issue. It will be accompanied by a title page for the volume, for the convenience of those who bind their issues.

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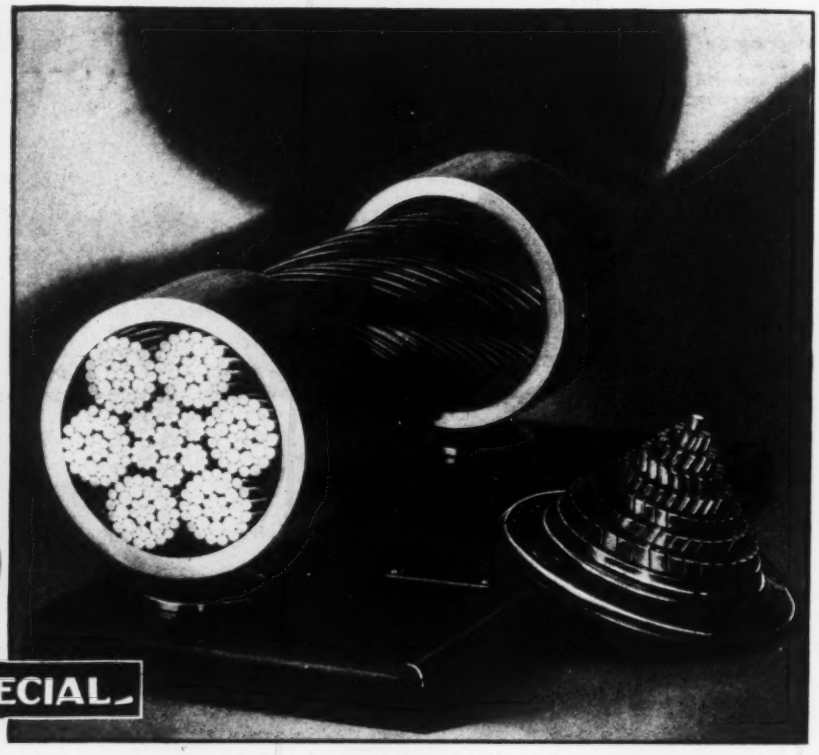

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ENGINEERING NEWS-RECORD

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January 11, 1934

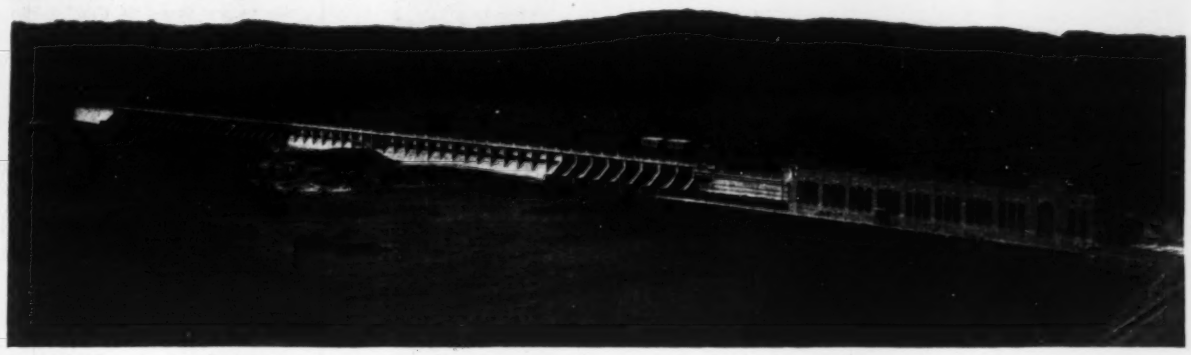


FIG. 1—THE DAM of the Safe Harbor hydro-electric plant on the Susquehanna River below Columbia, Pa., consists of four principal elements: the power house, a group of spillway gates with four regulating gates controlled from the power house, a bulkhead section across an island, and a series of spillway gates across the far channel.

Important Design Elements of the Safe Harbor Hydro Plant

By Paul E. Gisiger

Structural Engineer, Safe Harbor Water Power Corp., Baltimore, Md.

ALTHOUGH construction of the dam and of the initial section of the power house together with the installation of the first generating units in the power plant of the Safe Harbor hydro-electric plant was completed about two years ago, little has been written to put on record some of the important details in the design of the dam and hydraulic structures that mark progress in the art of building water-power plants. The following article by Paul E. Gisiger, the structural engineer, does not attempt to give a complete description of the project but rather sets forth the features, hydraulic and structural, that are believed to be unusual or different from standard practice. General data are given only as far as is believed necessary for a clearer understanding of the parts and features described. A subsequent article will give some of the important elements of the construction operations. —EDITOR.

THE SAFE HARBOR development is located on the Susquehanna River about 10 miles below Columbia, Pa., and 30 miles above tidewater. Below it are the Holtwood and Conowingo plants, the three plants together developing power from a fall of more than 200 ft. The Safe Harbor plant develops a gross head of 55 ft., and ultimately will have an installed capacity of 510,000 hp.

The purpose of the dam is to back up the water of the Susquehanna River to El. 225 (later El. 227) above sea level, and to allow any flow the river may reach to be discharged without the pond exceeding this elevation. The original water surface at the dam site varied between the extremes of El. 165 and 191, being about El. 172 for the average discharge of 40,000 sec.-ft. The river bottom under the axis of the dam had the extreme elevations of 145 and 193 ft., the former representing the bottom of a deep cut along the east shore, the latter the top of an island in the middle of the river. Except on this island, the mica-schist rock of the riverbed was generally bare and provided an excellent foundation for the dam, spillways and power house.

The highest flood on the Susquehanna River on record is the one of June 1, 1889, which is assumed to have been 725,000 sec.-ft. from a drainage area of 26,090 sq. miles above Safe Harbor. Floods above 600,000 sec.-ft. occurred in 1869 and 1894. During this century 590,000 sec.-ft. was recorded in 1902, and at least once more a momentary discharge of 600,000 sec.-ft. was reached through the sudden breaking up of an ice jam in late winter. From the frequency of these floods, as well as a study of the meteorological conditions that produced the 1889 flood, it was concluded that at least 900,000 sec.-ft. should be provided for.

As finally built, the dam can discharge, in excess of flow through the power house, 970,000 sec.-ft. at the initial pond elevation of 225 ft. and 1,150,000 sec.-ft. at the ultimate normal pond level of 227 ft. for which all structures are designed.

The river valley at the development site is about 5,000 ft. wide. After allowing for power house and abutments on each end, a length of 3,650 ft. remained for the dam. In early designs all of this was utilized for spillway, locating the crest as high as possible for the given length and the required discharge capacity. It became evident, however, that by increasing the depth and reducing the length of the spillway, a considerable saving was possible. This saving is produced in three ways:

1. A certain length of spillway is replaced by an equal length of non-overflow bulkhead, which latter, within the range of the heights in question, has less concrete volume than spillway plus piers.

2. Lowering of the spillway crest reduced the concrete volume of the spillway proper, and,

3. Reducing the number of gates by making them deeper decreased the total tonnage of steel in gate equipment, in spite of heavier single gates.

Consideration of all of these factors led to the choice of El. 195 for the permanent crest, requiring a total clear spillway length of about 1,500 ft. to give the required discharge. While a clear gate opening in the neighborhood of 40 ft. would have been somewhat cheaper, 48 ft. was adopted because the severe ice runs that occasionally occur on the Susquehanna made a wide opening desirable.

As shown in Fig. 2, the 32 gates are separated into two groups of 24 and 8 each, called respectively west and east spillway. By using the west channel of the river alone for spilling excess river flow, the tailrace elevations are materially reduced. Of the eight gate openings of the east spillway, four are used for close regulation of the pond level, and the other four only occasionally.

The shapes of spillway and apron were selected after conducting model tests in the Alden Hydraulic Laboratory of the Worcester Polytechnic Institute. The downstream face of the spillway has the usual parabolic shape, with the parabola a function of the normal head ($x^2 = 2.03\ Hy$), and continues into a fairly large bucket, the downstream edge of which is about 5 ft. higher than the bottom. The point of view in testing and deciding on this shape was not to reduce erosion to the absolute minimum but rather to locate the point of attack as far downstream and away from the dam as possible.

For the shape and volume of bulkhead and piers, the question of ice pressure is important. Its influence on the gates and piers was minimized by the installation of a compressed-air bubbler system. However, as a matter of safety, 4,000 lb. per linear-foot of ice pressure was assumed to act on the gates at normal water-surface elevation and to be transmitted to the piers.

At non-overflow bulkhead sections where ice pressure has to be expected, 10,000 lb. per linear-foot was assumed. This caused tension on the upstream side in the upper third of the bulkhead sections, which are therefore reinforced.

Foundation drainage and uplift were taken care of by providing a drainage tunnel inside of spillway and bulkhead with its floor slightly above normal tailwater elevation. From this tunnel, at a distance of 10 ft. from the upstream face of the bulkheads, vertical 4-in. pipes spaced 18 ft. apart longitudinally go down and end in a box that follows the foundation joint for the full length of

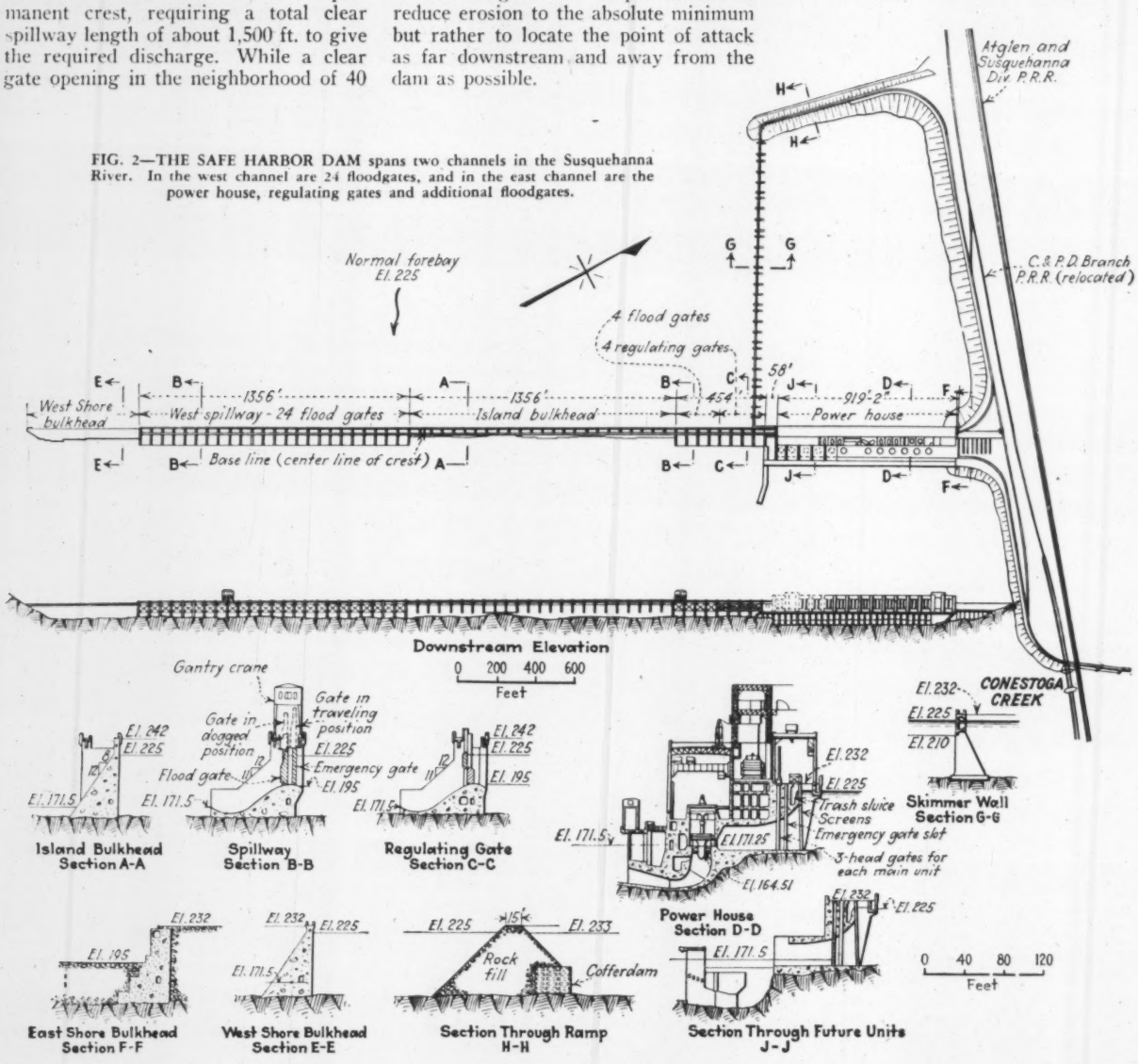


FIG. 2—THE SAFE HARBOR DAM spans two channels in the Susquehanna River. In the west channel are 24 floodgates, and in the east channel are the power house, regulating gates and additional floodgates.

the dam but is interrupted at each pier. Water percolating from the upstream side along the foundation joint is intercepted at this box, and, if enough pressure is present, will rise in the pipes until it overflows into the drainage trench of the inspection tunnel. From there it can flow out through another set of pipes to tailwater.

The uplift assumptions used for the stability analysis of the dam are based on this system of drainage. Uplift is assumed to be equal to full head at the heel, to decrease at a uniform rate to the line of the longitudinal box drain where it is taken to be equal to the head from the base to the bottom of the drainage tunnel (overflow edge of vertical riser pipes) and to decrease from there to the head of the tailwater at the toe.

Transverse contraction joints, which are provided at each pier, are broken by vertical keys and sealed on the upstream side with a U-shaped copper plate.

Control gates

As to the type of gate to be used, tainter, rolling and stoney gates were given serious consideration. Stoney gates were decided on for the following reasons:

1. Although they require more tonnage than tainter gates, the use of the latter for openings of a size here desired was unprecedented and would have produced serious problems at the trunnion points and in the trunnions and bearings themselves.

2. For safety of operation the provision of emergency gates that could be handled with the same equipment and under the same conditions as the regular gates was considered indispensable. This, as well as their much greater weight, ruled out rolling gates and minimized the advantage of the lower weight of tainter gates. The provision of an emergency gate slot in front of the latter complicates the layout of piers, and, as a gantry crane of sufficient capacity to handle the emergency gate would be required, would not allow taking advantage in the hoisting equipment of the smaller weight of tainter gates.

3. Heating of sealing faces is easier with stoney gates.

4. Stoney gates could be taken out, replaced, transported and interchanged with normal operating equipment, which is not possible with any other type of gate.

For close regulation of the pond level double-leaf regulating gates were installed in the four spillway openings next to the power house. These regulating gates consist of an upper and a lower half moving independently of each other, with the upper halves operated by individual chain hoists (Fig. 4). As shown in the cross-section, the upper leaf is placed on the downstream side of the lower leaf and can be lowered past it, so that in the extreme position the tops of both gates are at the same elevation, 12.5 ft. below normal pond elevation.

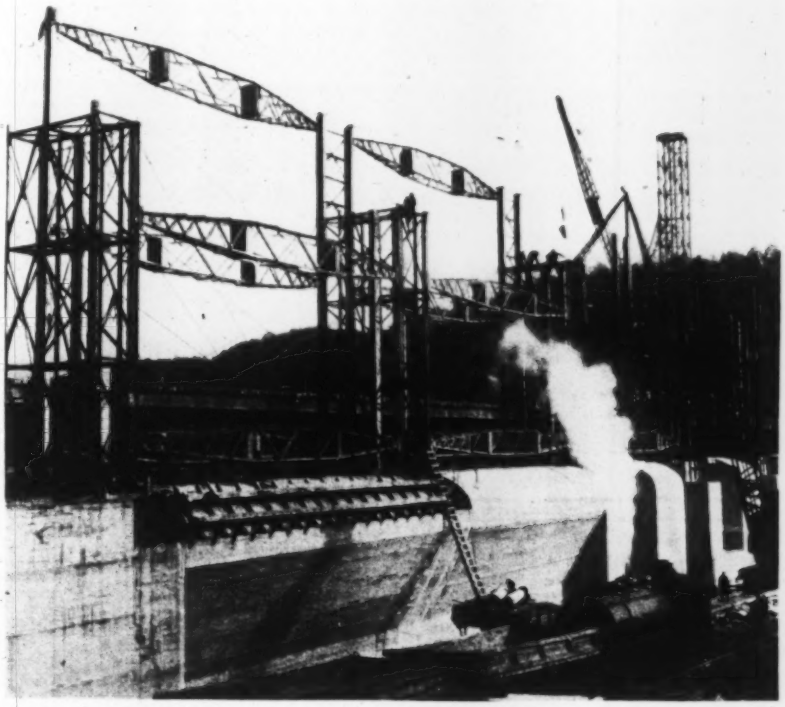


FIG. 3—ERECTION of the gate guides, showing braced-steel towers framed to support the gate guides, roller tracks, etc., also the spacer beams to keep the opening lined up to the exact width. At the right are the temporary river-control openings through the spillway.

The lower leaves are operated and handled the same as the floodgates. Their vertical end girders are carried up to the same elevation as the top of the floodgates and are provided with a lifting lug, which fits the common lifting beams. The seal between upper and lower leaves consists of a brass spring plate connected to the lower leaf and sliding on brass strips on the upper leaf. These seals are equipped with electric heating elements inclosed in pipes. The hoists for the four upper-leaf regulating gates are located in a tunnel in the body of the spillway. Their operation is by remote control from the bench board in the power house. Push-buttons to lower, raise or stop the gates are mounted on a panel, together with water-level indicators and gate-position indicators. The total discharge from the four upper-leaf regulating gates, when fully open, is about 26,000 sec.-ft., and the fact that the spillway discharge can be regulated within this amount from the control room without having to send men out on the gantries permits keeping the pond level constantly at or very close to the permissible maximum. The operators have experienced no difficulty holding the forebay level within a few tenths of a foot for a number of days, during which the spillway discharge varied from 25,000 to 140,000 sec.-ft.

The design of the floodgates follows conventional lines. Seals for flood and emergency gates are brass spring plates, with phosphor bronze wearing bars along the sides and molded rubber strips at the bottom. The rubber strip, as well as the steel bottom edge of the gate, bears against an H beam embedded into the spillway crest; the wearing bar of the vertical side seals slides on a strip of non-corrosive steel welded to the guide structure.

In design and construction of gate guides the usual method of bolting and grouting the steel or cast-iron guides into recesses left in the concrete of the piers was not followed. It was found that with the heavy material required for roller tracks, seal plates, etc., a very stiff tower could be developed by the addition of a relatively small amount of bracing. Consequently, all the guides going into one pier, consisting of roller tracks, sealing faces, heater boxes, etc., for two adjacent gates, were combined into one steel tower structure and erected in place before the piers were poured. In order to keep each opening lined up to the exact width, temporary spacer beams were placed between piers during the concreting operation. A considerable saving in time and labor was effected by this method through the fact that piers and guides were complete when the forms were removed.

Provision is made at all floodgate guides for heating the roller tracks and the sealing contacts. For this purpose the roller-track supports form a box, and a similar box of sheet metal backs up the seal plates. Electric heating elements can be placed in these boxes, and have been provided so far on the upper-leaf regulating gates and on four floodgates.

The gates have a minimum freeboard

of 3 ft. under any operating condition to insure against loss of water and accumulation of ice on the gates during high wind. It was required also that the gates in dogged position, as well as the bottom of the operating bridge, should be at least 7 ft. clear of the overfalling nappe. This brought the level of the spillway bridge 15 ft. above maximum pond elevation. By separating the up- and downstream girders of the operating bridge entirely and cutting a notch into the tops of the piers, the gates can be transported along the spillway with their bottom edge below the gantry rails, whereby the height of gantries was reduced.

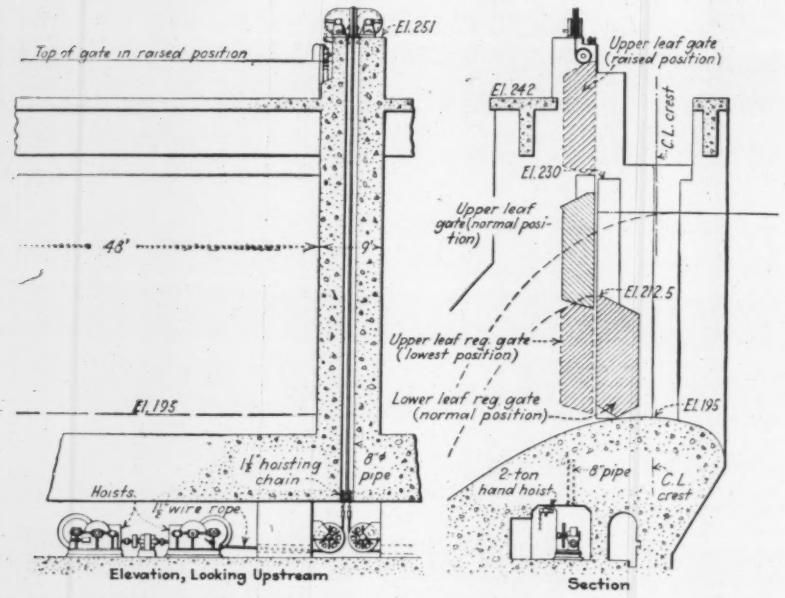


FIG. 4—METHOD OF OPERATING the four regulating gates on the spillway.

Skimmer wall

All water not spilled over the dam enters the power house forebay by passing under the skimmer wall. This is essentially a curtain supported on piers with its lower edge 15 ft. below the water surface. Its top serves as a walkway. At ultimate full load on the power plant the water will go through the skimmer wall at a velocity of 1.7 ft. per second. The skimmer wall is designed as a structural-steel frame incased in concrete. The advantages of this type of structure which led to its use wherever feasible, are: avoidance of shoring and falsework under beams and girders; saving in time due to this and to the fact that forms can be removed sooner than under bar-reinforced structures; and favorable steel prices.

The skimmer wall is designed for a factor of safety of two against overturning for 4,000 lb. per linear-foot of ice pressure from the river side and 2,000 lb. per linear-foot from the forebay side. As a precautionary measure, air bubblers were installed on both sides to prevent formation of a solid sheet of ice against the wall.

To allow for expansion, the wall was built in sections, an expansion joint going through the center of every fourth opening, which is only 30 ft. wide, while the regular openings are 53 ft. wide. Each section of the skimmer wall is, therefore, a continuous girder over three 53-ft. spans, with a 15-ft. cantilever at each end.

During the first year of operation the effectiveness of the skimmer wall has been very apparent. While at the Holtwood plant, 9 miles downstream, where the skimmer-wall protection is not complete, some severe trash runs, with attendant work on the screens and reduction of output, were experienced during this time, no trace of any clogging up of screens nor any evidence of trash getting into the forebay were noticeable, while large amounts of floating matter collected in the corner between skimmer wall and dam and were discharged over the regulating gates.

Power generators

The power house takes up about 1,000 ft., or 20 per cent of the total width of the river. Considerations of access indicated that it be located near the east shore, across the main low-water channel of the river.

One of the most important questions to be decided with regard to the power-house layout was how far to go in providing for future units. While space was allotted for an ultimate number of twelve main units and two service units, five main units and two service units have been installed so far and are in operation. The power-house superstructure is completed for these five as well as two additional main units. The latter two are located at the land end. Their completion will require only the installation of machinery (which is now on order for one of them), the upper part of the scroll case and the operating floor, which structures were left out because these two units are expected to be provided with single-phase, 25-cycle generators for railroad current and may be slightly different from the others.

The main units have a rated capacity of 42,500 hp., at a head of 55 ft. and a speed of 109.1 revolutions per minute. They are five-blade propeller wheels with automatically adjustable (Kaplan type) blades. These are the first large-size turbines of this type to be installed in America and they were selected instead of Francis wheels on account of their higher efficiency at part load, higher speed and smaller space required for given capacity. The diameter of the turbine runner is 220 in., and the center line of the runner is below normal tail-water level in order to avoid excessive cavitation. The direct-connected generators of the initial five units are 3-phase, 60-cycle, 13,800-volt machines rated for 31,111 kva. at 0.8 power factor and 60° C. temperature rise.

The two service units are Francis wheels with steel-plate scroll cases. They are each rated 3,100 hp. for 55 ft. of head and 118 r.p.m. They occupy together the same space as one main unit and are located in the center of the power house as it will be when the ultimate number of twelve units is installed.

Of the five units beyond the present end wall of the power house, the intake section and the downstream end of the draft tubes with the stoplog slots are in place. Thus the unwatering operation for building a future unit will be reduced to dropping draft tube stoplogs and pumping out the pits. The intake section naturally had to include enough concrete to be stable against forebay water pressure and to be fully equipped with gates, except that no hoists were installed for the roller gates. These intakes were found extremely convenient in controlling the river flow during the final stages of construction.

All excavation in power house and tailrace for future units was completed at this time to avoid subaqueous excavation in the future. The fact that the downstream part of the structures for future units has to act as a bulkhead of considerable height when serving as a cofferdam for future construction, resulted in some unusual design features. The whole system is to a high degree statically indeterminate and had to be carefully analyzed for stresses developed at some future time under different temperatures, when stoplogs are dropped and water pressure is present, with the elastic properties of the concrete changed by aging, shrinkage and the effects of immersion followed by drying out.

The main dimensions of the power-house substructure are 172 ft. of over-

all width and 62 ft. of length per unit. The low-tension equipment occupies 40 ft. of width between the generator room and the intake structure. This produced a fairly long intake waterway and made possible a gradual transition from the large cross-section at the screens to the smaller cross-section near the scroll case. Each unit intake is subdivided into three waterways by intermediate piers. For construction the substructure was divided into blocks of two units each, with a contraction joint between each pair of units. Tops, bottoms and piers of draft tubes, as well as intakes, were figured as a system of continuous frames for each pair and were reinforced accordingly. The intake piers, especially the split ones at contraction joints, had to be heavily reinforced. Water passages and other voids in the substructure form 46 per cent of the gross volume. This is probably high for this class of structure, and it forced the designers to give close attention to every part, because no possible source of stress could be overlooked by depending on large thicknesses of concrete to give safety against excessive stress and leakage. The course followed was rather to make a complete analysis of each part, to dimension and reinforce adequately for the assumed forces, and to use a mix of concrete that would give a high impermeability as well as sufficient strength.

The intakes to the turbines are located as deep as was possible under the given natural conditions because submergence was considered essential to avoid ice troubles. The intake floor is, therefore, at about forebay bottom elevation. Slots for regular and emergency gates are downstream of the trash screens, which latter have a batter of 1.24. Trash screens are assembled as removable sections, of which four are required for each of the three openings of one unit intake. As the propeller and Kaplan type wheels called for in the design of this plant are able to pass fairly large pieces of trash without suffering damage, a center-to-center spacing of 7 in. for screen bars was adopted. It was found that even with this wide spacing and the low velocities involved, the use of streamline-shaped screen bars was likely to reduce the head loss at the screens an amount sufficient to justify the cost of a specially rolled bar. Its shape corresponds to one developed and tested by the U. S. Navy for an airplane strut of minimum wind resistance. The bars rest on intermediate horizontal and vertical supports which, instead of I-beams, are flat plates with their leading edges rounded off. The bars are connected to these plates by welding them into notches cut into the plates. Structural shapes with their large flanges are thus almost eliminated from the screen area. The screens are figured to hold an unbalanced head of 15 ft. of water with normal working stresses.

Provision is made for a mechanical trash rake, but none has been installed so far.

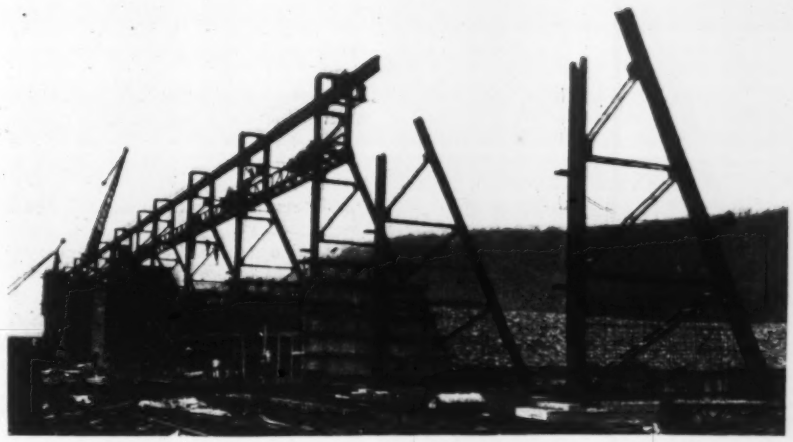


FIG. 5—STEEL FRAMING for the reinforced-concrete skimmer wall across forebay.

Additional features installed to insure uninterrupted operation of the screens are compressed-air outlets near the bottom of the screens to loosen up trash, and provision for electrically heated screens.

The intake gates are all of the same size, but while the center gate of each intake travels on fixed rollers and is operated with a motor-driven screw hoist, the two outside gates are sliding gates and are operated with either of the two intake gantry cranes. The screw hoist of the center gate will lift or close this gate against full unbalanced water pressure, plus a large allowance for friction and binding. The sliding gates can be lifted or dropped only when the scroll case is filled. With an empty scroll case, therefore, the center gate has to be lifted ahead of the two other gates to allow the casing to fill. In case of motor or hoist breakdown, the casing can be filled slowly through an 8-in. valve built into the sliding gates.

The omission of hoisting mechanism of two-thirds of all headgates results in a considerable saving and slows up the starting operation only to a negligible degree, as a unit can be started with the center gate alone open. The hoisting speed of the latter is 5 ft. per minute.

The emergency gates are similar to the sliding headgates and are also operated by the gantry cranes. A 12-in. valve is built into each of these gates, which opens as soon as the slack is taken out of the chain by which the gate hangs on the crane, and which serves to fill either the scroll case or only the space between emergency headgates and regular headgate before the former can be lifted.

The seals of the headgates are rubber moldings and brass spring plates identical with those used for the spillway gates.

The concrete slab above the intakes and scroll case is the floor of the low-tension bus room and generator room. There is no intermediate floor below the generator room, as in many other hydropower stations. Omission of such a floor was economical structurally and simplifies supervision of equipment, as all auxiliary mechanical and electrical equipment is located on one floor and within full reach of the cranes. The condition, however, that the main operating floor is directly over the top of the scroll case with only 6 ft. of concrete in between, the top 15 in. of which had to be placed separately on account of piping and conduits, required extreme care in reinforcing against stresses from all possible conditions and called for concrete of uniform and high quality. No cracks or damp spots have shown on this floor, which is covered with a dark red colored concrete finish. In the bus room, where leaks would be less conspicuous but even more objectionable, and which has water pressure against the upstream wall as well as under the floor, double walls and floors were used to insure watertightness.

The thrust bearings supporting the rotating parts of the generating units are located below the generator, contrary to the most usual arrangement for vertical shaft hydro units. Thereby several feet of building height could be saved. Structurally, however, a difficult problem was introduced because the weight of the machinery had to be transmitted to the foundations at a very low elevation close to the scroll case, where not much mass is available to distribute the loads and the concrete is already stressed from water pressure. The problem was further complicated by the space requirements for clear pit opening and for ventilation and governor piping, which placed limitations on size as well as location of supports, which latter had to be different for each of the two makes of generators installed.

The power-house superstructure varies somewhat from the usual in so far as the crane rails are located very low, and the two cranes are raised above their trucks on legs, making them short-legged gantry cranes. This arrange-

ment was developed to suit the transformer-handling requirements and also saved some tonnage in superstructure steel.

Transformers are located between power house and intake deck, and the elevation of the transformer deck was governed by the vertical space requirements of the electrical bay below. Transformers can be shifted around on a special transfer car running on an 8-ft.-gage track on the intake deck along the transformer banks. When received from the manufacturer, they come in, however, on the generator floor, where they also have to be brought for untanking. For transfer from generator floor to intake deck a part of the assembly space at the land end of the power house was developed into a transformer-handling bay by making the building high enough to lift transformers from the generator floor to transformer-deck elevation. This is done with a special 250-ton transformer crane traveling at right angles to the power-house axis and above the generator-room cranes. Transformers can be lifted with this crane from the generator-room floor and set down at transformer-deck elevation in an upstream extension of the generator room. From there they are rolled out on the transfer truck. In this operation the transformers are lifted across the upstream rail of the generator-room cranes. Therefore, this rail could not be placed higher than the transformer deck, which led to the above described power-house crane arrangement. With the crane girders at the same elevation as the transformer deck, horizontal reactions from the generator-room cranes are resisted by this deck and do not produce bending stresses in the lower part of the building columns, a very desirable result, as these columns already have a heavy direct load.

The two generator-room cranes have each two 125-ton main hooks on separate trolleys and two 20-ton auxiliary hooks. The heaviest single piece of the initial installation, the 220-ton generator rotor, is lifted with a lifting beam suspended from the two main hooks of either crane. The rotors of the 25-cycle single-phase generators, which are to be installed at a later date, are expected to weigh from 400-450 tons and will have to be handled by the two cranes combined.

The turbine runner, weighing 135 tons (shaft included), is handled with a different lifting beam also suspended from the two hooks of one crane. This beam has a circular center piece that fits around the turbine shaft and is supported on a ball bearing so that the turbine can be turned when suspended.

The transformer deck is the roof of the low-tension equipment structure and, therefore, had to be waterproof. The possibility, however, of oil being dumped out of a transformer in case of fire, or merely the chance of oil leaking out of piping eliminated the normal tar, pitch or asphalt roofing, because these materials do not stand up under oil. After several other materials and methods were investigated, it was decided to use copper sheeting covered with a 3-in. wearing surface of concrete. The transformers stand on raised beams, which together with the bases of the compartment walls and the curb against the intake deck, form three separate basins under each transformer, each having a 12-in.-diameter drain connecting to the oil dump lines. Bottom and sides of each basin are covered with 24-oz. copper sheeting. All joints in the copper are folded over and soldered.

The Safe Harbor development has been under preliminary study by the engineering staff of the Pennsylvania Water & Power Co., for a number of years. The first concrete was placed Aug. 1, 1930, and the first unit was put in operation Dec. 7, 1931. The development is built, owned and operated by the Safe Harbor Water Power Corp. All design and engineering work was under the direction of J. A. Walls, vice-president and chief engineer, with N. B. Higgins, assistant chief engineer, in charge of design and construction. W. W. Pagon was consulting engineer on special structural problems. The Arundel Corp., of Baltimore, was general contractor for all structures.

A Neglected Stress in Grillage Beams

By Robins Fleming
American Bridge Co., New York City

TO GIVE wider circulation to the thought embodied in an article on combined stresses in beams, by F. H. Thomas in *The Structural Engineer* (London), October, 1933, the writer presents the following:

An ordinary steel grillage beam is an inverted cantilever uniformly loaded in which both the bending and shearing stresses are greatest at or near its center. While the stresses may be examined separately, their *combined* effect is sometimes neglected.

The formulas given in textbooks are:

Maximum bending stress in tension:

$$T = t/2 + \sqrt{s^2 + t^2/4}$$

Maximum shearing stress =

$$S = \sqrt{s^2 + t^2/4}$$

from which if T is assumed,

$$t = \frac{T^2 - s^2}{T}$$

for varying values of s. And if S is assumed, $s = \sqrt{s^2 - t^2/4}$ for varying values of t. In these equations t = unit intensity of bending stress, and s = unit intensity of shearing stress.

Values of t and s for bending stresses (T) of 16,000, 18,000 and 20,000, and for shearing stresses (S) of 10,000, 12,000 and 14,000 lb. per sq.in. are shown in Fig. 1. The distribution of the bending and shear stresses of the 24-in. beam shown in Swain's "Strength of Materials" (p. 199) is as shown in Fig. 2.

It is seen that the value of combined tensile and shearing stresses is greatest at the fillet of the beam. At this point the intensity of bending stress (t_1) is ab/ac of that at the extreme fiber. The intensity of shearing stress at the fillet is also slightly less (in most cases negligible) than the average stress if considered uniformly over the web of the beam. In the diagram it is shown as 0.0344 of the total stress. If considered uniformly distributed, it is 1/24 or 0.0416 of the total stress.

It should be noted that there is a combination of bending and shearing stress in all beams under any condition of loading. This may need to be considered in beams supported at both ends and carrying concentrated loads, especially in those of short length. The maximum combined stress for both cantilever beams and beams supported at ends extends for such a short length that the writer does not hesitate to neglect it if the allowable bending or shear stresses are not exceeded more than 10 per cent—in some cases 20 per cent.

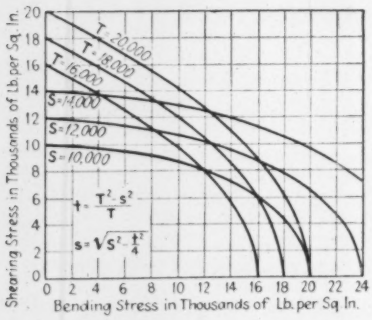


FIG. 1—RELATIONS between unit bending and shear stresses for several maximum shear and bending values.

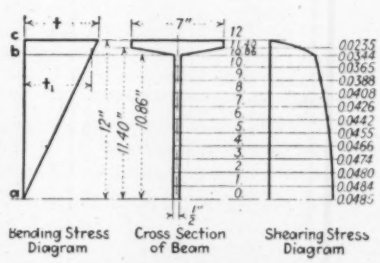


FIG. 2—DISTRIBUTION of bending and shear stresses in a 24-in. I-beam.

The CWA Program and Unemployment Relief

How four million men have been put to work in six weeks, what they are doing and how much they are accomplishing revealed by survey of a dozen cities from coast to coast.

MEN WORKING! Thousands of dusty, long-forgotten signs bearing this inscription have been brought out of storehouses to be scattered along roads and streets, sewer and water-line trenches, in parks, playgrounds and public buildings in every city and hamlet throughout the land. Men working! Four millions of them mobilized and organized in one of the greatest peace-time drives in history. On Nov. 7 last the Civil Works program was announced in Washington. In three short weeks 2,000,000 persons had been taken off relief rolls and put to work earning cash wages instead of grocery orders, free meals and rent checks. In another two weeks 2,000,000 more unemployed were once again enrolled on pay jobs.

Realizing that the 15,000,000 persons dependent upon those 4,000,000 workers would have to be taken care of in some manner this winter, the national government chose the humane offer of wages for work done rather than a resort to further charity and doles. The sum of $400,000,000 is being spent in this great endeavor. Every community is directly benefited immediately by weekly cash payrolls and the renewal of business and industry which they bring about, and permanently by receiving worth-while improvements of a lasting value.

At once, however, certain doubts and questions force themselves into attention. Is this CWA operation merely a new batch of made work? Are the workers turning out a full day's work and producing anything of value? How is the program organized and how does it function? Are its purposes being accomplished?

To get the answers to these and many other questions concerning the CWA plan, editors of this journal made first-hand observations of actual projects under way, at random in large and small towns. From these observations definite conclusions regarding the Civil Works program can be drawn.

The CWA is a success

First: Considering the speed of organization and magnitude of operations, the CWA plan has been excellently organized. Every official charged with responsibility, from Administrator Harry L. Hopkins down to the local supervisor in the smallest town, has worked unceasingly to get men to work. Almost without exception, local authorities were literally exhausted after six weeks of planning and driving, day, night and Sundays. A turkey sandwich in the office was the Thanksgiving dinner of many a CWA official.

Second: For the most part, the projects are well selected, sound and of lasting value. Naturally, conditions in some communities permitted a better selection of projects than in others, but so-called made-work jobs are few.

Third: Most of the workers are doing a good day's work, some credit for which is due the fact that they are subject to dismissal for non-performance, just as they would be on any job.

There are obviously exceptions to these general conclusions. In some communities the work seemed to be disorganized, with those in charge somewhat bewildered. Some projects border on the useless, though in most such cases these were temporary schemes created as stopgaps pending development of more worth-while jobs. And of course among 4,000,000 human beings will be found a considerable number of loafers, troublemakers and disgruntled agitators.

The Civil Works program is not a construction program. It is primarily an emergency unemployment-relief scheme designed to tide the country over the winter months until the Public Works program can get into full swing. It is doing what the Public Works plan has failed to do—take up the immediate slack in unemployment. Viewed from a construction standpoint, the work being done is inefficient and expensive, and no engineering public official would think of doing regular construction by these methods.

The cities considered in this survey were selected at random, and doubtless many other localities have as good or better organizations; but the following reports are believed to be a fair cross-section of what is being done throughout the country. These are typical cases singled out of thousands of similar operations.

A well-organized local program

A splendidly organized and smooth-working program was found at Springfield, Mass. This is one of the few cities where the city engineering department acts as administrator and supervisor of all CWA work. Cornelius W. Phillips, superintendent of the department of streets and engineering, is in charge.

MONOLITHIC-CONCRETE SEWERS built in hand-dug trenches form part of Springfield's CWA program. Steam boilers help fight the frost and protect fresh concrete. Long-unemployed workers ignore the cold and stormy weather.

For years Springfield has been doing all its municipal construction work by day labor, building up an efficient engineering and construction department. At the start of the Public Works program the city was able to get immediate approval for projects totaling $871,000 to be carried on by day labor. Even a federal road allocation of $196,000 for work on the Boston Post Road within the city limits is being handled by the city engineering department. With the advent of the CWA program, the city was in an excellent position to take

advantage of the funds offered to put men at work.

Plans for worth-while projects were immediately prepared and approved, contemplating expenditures of $448,838 from the CWA funds, supplemented by an appropriation of 25 per cent additional by the city, amounting to $112,250, for all tools, equipment, materials and supervision required. Subsequently, additional plans were approved calling for expenditures totaling $275,415, of which 25 per cent was to be furnished by the city. This gave the city a total of $836,503 for CWA work, and a grand total of $1,904,203 for all relief construction work.

The Civil Works program being carried out in Springfield is employing 3,140 men, with a total of 1,144,260 man-hours. The program consists of secondary highway construction, beautification projects in the various parks and on roadsides, erosion and drainage work in the parks, the grading and filling of an area of approximately twelve acres for an athletic and recreation field, laying secondary stormwater drains, painting 600 classrooms in 24 school buildings, painting offices and corridors in the administration building and auditorium, and employing 50 stenographers and clerks in the assessor's office to compile and revise records.

The department of streets and engineering has set up an administrative branch which consists of a field office located near each job under construction, and which handles directly the time, materials and other field reports. A payroll and accounting bureau has been set up at the city hall. About 260 engineers and clerks are being employed in the office and in the field. At the start, complete unit-cost estimates were made of each project. Accurate daily and weekly cost records are kept, and whenever the cost exceeds the estimate the foremen are held to account. A timekeeper and foreman are assigned to each group of 70 men.

When seen in a temperature of 8 deg., with a stinging sleet in the air, every job was under way, and no bonfires for keeping warm were allowed. On the monolithic-concrete sewer projects steam boilers furnished live steam for protection of fresh concrete. All projects are worked six hours daily, five days a week, except these heated projects where 48 hours per week are permitted to save fuel. No man is allowed to work more than 30 hours per week. Workmen told of being glad to be at work and having pride in what they were accomplishing. And most obviously they were telling the truth.

Common labor is paid 56c. per hour, to correspond with the regular city scale. Trucks, air compressors and other pieces of equipment are rented as needed and paid for according to size. Foremen, engineers, timekeepers and clerical help are paid by the week, varying from $16 to $35. Tools are checked in at the end of every shift, resulting in little loss and permitting repairs to be made.

TYPICAL VARIETY OF CWA PROJECTS SHOWN BY TYPES OF WORK IN MASSACHUSETTS

1. Road grading and surfacing
2. Street widening and surfacing
3. Playgrounds
4. Sewers, catchbasins and manholes
5. Water-line extensions
6. Building repairs
7. Forestry and reforestation
8. Shore walks
9. Dikes and revetments
10. Cleaning up watershed
11. Mosquito control
12. Drainage
13. Cemetery improvements
14. Opening gravel pits
15. Park improvements
16. General clean-up of city
17. Sidewalks
18. Golf-course construction
19. Painting public property
20. Moth control
21. Clearing public lands
22. Building fire lines
23. Clerical work
24. Water holes
25. Fish-pest eradication
26. Game farms
27. Concrete retaining wall
28. Swimming pools
29. Repairing stone walls
30. Surveying
31. Building grandstands
32. Engineering studies
33. Bulkhead construction
34. Sewage-filtration plant
35. Grading and filling public lands.

Illinois work expedited by engineers

By early appointment of an advisory board of engineers, which set up an engineering division in the CWA, Illinois was able to put into the field its full quota of men at meritorious jobs by the Dec. 15 deadline. The prevailing type of work being done is earthwork (involving grading, surfacing, drainage and ditching), clearing brush, tree trimming, tree removal and planting, street repairs, resurfacing and widening, painting, renovating and remodeling of buildings and general repair and clean-up work.

In Cook County certain large jobs are being used as a pool or reservoir on which men may work until organization and equipment for smaller and perhaps more important jobs can be set up. Leveling the spoil banks of the canals of the Sanitary District of Chicago is one of the largest pool jobs, some 20,000 workers being occupied on it, using mostly picks, shovels and wheelbarrows to move the material to the adjoining right-of-way or to private property.

In Chicago the water-pipe extension division of the board of public works is using 4,500 men as inspectors of every water service in the city, looking for leaks. Oscar Hewitt, commissioner of public works, reports that the finding of early investigation indicate a greater saving will be made than the 200 m.g.d. of waste that it was at first believed could be stopped. The various parks and playground authorities are using nearly 6,000 men on landscaping, earth leveling, shrub and tree planting and general park improvements.

The Board of Public Works in Chicago is carrying on a large program of street-repair resurfacing and repaving. Eventually 20,000 men will be at work repairing brick pavements, mainly by turning the brick and relaying on a releveled subgrade. About 25 per cent of new brick will be used. Several suburbs of Chicago are also relaying brick pavements. The result is not of the best because sand cushion and sand filler alone is being used, yet it is a decided improvement.

Asphaltic concrete in residential streets is being used as resurfacing on old macadam that has been scarified by picks, releveled and tamped by hand. The resurfacing material has been obtained at an extremely low figure both from city and private plants. Less than $4 per ton is the price mentioned, whereas the former price has been $13 and $14, but the specifications are quite different than usual. Large contractors have cooperated in a meritorious way, but much credit for the low costs must be given to the engineers whose efforts were spurred on by the small amount of money available for material. More than 8,000 men will soon be engaged on asphalt paving jobs. Both hot and cold mix are being used. Specifications were prepared by J. J. Butler, of the street department, Gene Abson, of the Chicago Paving Laboratory, and Prof. J. S. Crandall, University of Illinois.

Supervision in general is being provided entirely by the political subdivision for which the work is being done. Illinois had an elaborate state emergency relief commission, the machinery of which was taken over by and merged into the CWA organization, which obtained registration of all unemployed who desired CWA assignments.

The engineering division of the CWA in Illinois was set up late in November, and within three weeks had expanded its staff to 300, to cover the whole state. Soon it took over the purchasing of all materials, though originally the duties were intended to cover mainly passing on projects from the engineering standpoint and very general supervision to check up on the local progress and results. It is now starting on the development of less simple, though perhaps more socially important, projects.

No heavy equipment is being purchased. Trucks in small number are being rented, mainly from the city and park boards. A 5-ton truck with driver, usually costing $27.50 per day, is being obtained at $18 per day. The Lincoln Park Board is using one steam shovel.

GRADING OF ROADS comprises the bulk of work in the San Francisco Bay district. Here is shown a typical job in Oakland.

its own. Road rollers for the asphalt pavements and subgrade are rented from the city and from contractors. Picks and shovels make up the bulk of equipment, and a real shortage, imminent at one time, was averted. Second-hand tools in large numbers were obtained from railroads and contractors.

As to the efficiency of the labor: the rating is naturally below that of picked forces on regular construction. But most men are willing to do a day's work, and the inefficiency is usually not the fault of the men but of the circumstance of the job. Often too many men are put on a job, or proper tools are lacking. Various other unavoidable causes reduce the efficiency that can be obtained in this emergency work.

Frank D. Chase, consulting industrial engineer, is chief engineer of the engineering division of the Illinois CWA, which was set up in record time by an engineering advisory committee headed by Prof. W. C. Huntington, of the University of Illinois.

Extensive grading operations

In California, out of the allotment of 10,500 jobs for the East Bay area (Alameda County) and the 16,000-job allotment for San Francisco, about 75 per cent of the workers have been assigned to grading projects in streets, roads, parks and playgrounds. This work is the usual pick-and-shovel type of operation, wheelbarrows being used generally for distribution of excavated material, though trucks are brought into use for long hauls. Grading work was selected primarily because of the ease in getting work under way promptly.

In the East Bay District much of the work is on hillside roads in newly developed sections of cities where improvement is desirable in widening roadbed and improving curves. This type of work is ideal for hand labor. A stream-straightening project is employing 1,000. In general, the gangs work in two five-hour shifts per day, an arrangement made necessary to avoid a shortage of tools.

San Francisco is grading and leveling playground areas, using about 2,000 men, while 2,000 more are being employed in the parks in grading roads and trails and general clearing operations. Excavation on two city boulevard jobs that had been under way as relief projects was stepped up to provide work for 6,000, and another contingent of 3,000 is employed in excavating for a distribution reservoir. In San Francisco the operations are carried on with one six-hour shift per day, working five days a week.

Projects other than grading range through painting and repair of public buildings down to the job assigned to one man—to study and preserve a practically extinct Indian language. Many of these jobs do not involve any engineering features or requirements. One of the interesting developments is a San Francisco project which provides for setting up an organization to be known as the "San Francisco Municipal Development Project." This organization will be headed up by a committee of local engineers and architects which intends to use about 400 engineers, draftsmen and architects in working out plans for the improvement and beautification of the city. Another type of project is that of making various surveys, including traffic counts, which provides work for both men and women and also clerical help.

In San Francisco supervision is by the CWA, including the providing of foremen, superintendents and engineers. The engineers receive instructions as to line, grade and results to be obtained from the city department which normally supervises that type of work. The foremen and technical help are selected from the registration lists. In the East Bay area the CWA supplies the foremen, but there is more direct supervision and control of the projects by the municipalities. In both cases there is excellent cooperation between the CWA officials and the municipal departments.

The amount of materials needed for all work in the bay area is relatively small, and for the most part they are being supplied by the CWA organization. In Oakland the city is furnishing pipe for sewer projects and culverts and drains for street work. Equipment required is rented and paid for out of CWA funds.

Measured strictly by unit cost of material moved, the grading operations are admittedly much more expensive than if done by regular methods. It is the general opinion, however, that this type of work must remain the backbone of the CWA program in order to take care of the large number seeking employment. The men themselves are anxious to work and are sincere in their efforts. On a large grading job all but 1 per cent of the crew showed up one morning in a pouring rain, equipped with adequate clothing and ready to work in the mud. Officials in charge expressed the opinion that the CWA program is the best relief plan yet devised until more permanent work can be provided for the thousands unemployed.

Road work in Cleveland area

Road work provided occupation for the first rush of men employed in the Cleveland area. Early in December, out of 39,500 working under the CWA banner, 22,000 were on highways, 13,000 of them on the state system, and another 9,000 on county roads. Officials recognize that this is a topheavy distribution of men on highways, and are making every effort to get other projects under way.

The CWA program is divided into four classes: (1) city and county, (2) village and suburban, (3) state highway work, and (4) miscellaneous, including schools, etc.

Supervision was supplied at first by engineers in the employ of the state highway, city and county departments. A department engineer, foreman and timekeeper were assigned to each project. As the projects grew in size and number, with additional thousands being put to work daily, the supervisory force became inadequate, and supervision nearly got out of hand. An administrative project was hurriedly established to provide additional supervision. In this area a margin of 10 per cent of the cost of each project is allowed for supplies and equipment.

It is estimated that in the first weeks of the program the efficiency of the work was about 50 per cent of what could ultimately be expected. But as work got under way, the efficiency increased, resulting in a much higher return for the money spent. Special consideration has been given to men with military training and previous experience, and the discipline that these groups are bringing to the various jobs is a real contribution.

Pay rates vary from 60c. per hour for common labor to $1.20 for skilled workers. Practically no equipment is being used with the exception of trucks, which are rented as needed. Stockton Raymond is county Civil Works direc-

STREET REPAIRS are prominent among CWA projects. In Wheeling half of a long-neglected street is being resurfaced with crushed stone produced by a CWA quarry project.

tor, and he is assisted by J. Kimball Johnson.

Rochester and Jamestown

On Dec. 16 about 8,000 of the total allotment of 16,000 men had been put to work on civil works in Rochester and Monroe County, N. Y. Projects were being approved at a rapid rate, however, with the expectation that the full quota would be at work by the end of the year. The city and county are combined in one CWA administration headed by Alfred Gates, executive director. The city projects are planned by Mr. Gates and the city engineering department. They include sewer extensions, park improvements and painting and repair work.

The county projects are planned and supervised by the county highway engineer, and consist mostly of road work. Both county and city contribute all funds needed for materials and equipment, leaving the CWA allocation for labor payrolls. Rates of pay vary from 50c. to $1.20 an hour, with intermediate rates for professional and semi-skilled workers. The work-week consists of four days of 7½ hours each, leaving Friday and Saturday for make-up days for time lost due to bad weather.

Numerous professional men and clerks have been taken care of, each project being supplied with engineers and surveyors as needed. Most of the clerks employed are in the administrative offices. The administration is decentralized, causing some confusion. City departments are located in two buildings, the county department in another and the administration headquarters in a fourth. Director Gates stated that the men were trying to do a full day's work and that the efficiency of the work was high, especially as compared with former relief-work projects.

About 500 are at work on CWA projects at Jamestown, N. Y. Public land and park improvements, drainage work and highway betterments (practically all grading work) predominate. The city furnishes all tools, equipment and materials needed. Leonard Bergman, city engineer, is CWA administrator. A fund of $5,000 has been set aside for the employment of engineers for supervising the projects and for making additional surveys on highway approaches to the city.

STRAIGHTENING a meandering creek through York, Pa., is providing work for 3,000. Industrial railroad equipment for handling material dug and loaded by hand seems incongruous, but this arrangement indicates an attempt at efficiency.

A shortage of engineers

At Wheeling, W. Va., an unusual condition exists. In all of Ohio County, which includes Wheeling and is under one CWA administration, only twelve engineers were registered and available for the supervision of 85 projects. The city engineering force had been depleted to one man because of municipal financial conditions, throwing the entire burden of engineering and planning on the CWA office. W. C. Smith, an engineer, is county administrator, and has done a prodigious job in getting work under way with the supervisory force available. Outside the city the county work is mostly state highway improvement, looked after by the state highway department forces.

Road and street improvements, including new curbs, predominate among the municipal projects. A quarry has been opened up to provide crushed rock for street surfacing. This quarry project is heavily manned, and the heavy overburden makes it an expensive operation, but it is easy to see that under all the circumstances the project is well worth while. The city and county have no funds to contribute for equipment and materials, and stone is important to the street work being done. About 20 per cent of the CWA funds are allotted for materials, equipment and supervision.

One of the main projects is regrading a hillside street, started under relief work, and installation of check-dams along the drainage ditch adjacent to the street to prevent erosion. Stone surface for this job is coming from the quarry. Another large project is the installation of an intercepting sewer along a street where abandoned street-car tracks are being removed at the same time. The old rails and ties become the property of the city. The ties are distributed for firewood, and the rails are being sold as scrap, the proceeds used for buying materials needed on other projects.

More than 200 women have been employed on a sewing project, the goods produced being distributed to the needy. A nutrition and health project, which

employs many nurses and case-workers, is looking after the welfare of the poorer children. Doctors and dentists are employed on this project on an hourly basis. The administration office is employing about 30 clerks. An unemployed barber was found late at night in the headquarters office shaving and trimming the hair of weary members of the administrative force who have found no time in the past six weeks to visit their regular barbers.

Extensive street and sewer work

Relaying brick pavements and turning over the original brick, constitutes much of the work at Huntington, W. Va., though several storm-relief sewer projects and street-widening projects are giving employment. City engineer R. W. Breece is in charge of all municipal work. The CWA supplies funds for materials up to 20 per cent of the total cost.

Start of work found the city engineering department short of help, as is the case in every West Virginia community. For the planning and supervision of city projects, 30 engineers were furnished by CWA, these men working in the city engineer's headquarters under his supervision. The city is supplying what equipment it has, additional equipment is rented by the CWA. Out of a county quota of 4,100 men, the city is using 2,000.

One of the large projects is the installation of a concrete pavement, all materials for which are being supplied by adjoining property owners. Another project is using mechanics for the upkeep and repair of city and rented equipment. A concrete wingwall is being added to a bridge. The park and planning commission is using some men on park work. The state is also using many skilled workers in the repair of buildings of state institutions located in and near the city. Two five-hour shifts are worked daily for six days a week. In all, more than half the county's relief registrants have found work under the CWA.

The city of Ashland, Ky., under the direction of city engineer C. D. O'Neil, is uncovering and repairing some 20 miles of sanitary sewer lines installed only six years ago by contract. Every foot of the lines is being uncovered. Few of the joints were found to have been properly cemented, if at all, and many broken sections of pipe are being replaced. Manholes were found to have settled considerably, breaking the adjoining lines of pipe.

Three creeks running through the city are being cleaned out and the channels widened, precluding further flood damage. Streets are being cut through in some cases to provide better access for fire trucks to various parts of the city. Parks are being cleaned up, and public buildings are being painted. The city is furnishing tools and equipment for all projects.

Every crew of 25 men has a foreman, and a superintendent is in charge of each project under the supervision of the city engineer. A state CWA ruling apparently prohibits the hiring of engineers as such, and all engineers required are hired as skilled laborers and are paid accordingly. Superintendents receive $1.10 per hour, foremen 66⅔c. and labor 45c. Five six-hour days constitute the work-week. The morale of the workmen seems high, instructions to foremen to fire any loafers are enforced, and a high rate of productiveness is being obtained.

Tax maps and flood control

Organization of the CWA administration at Richmond, Va., was delayed until Dec. 5. Then within ten days a complete organization was set up and a million dollars' worth of work put under way. Dr. W. B. Foster is local administrator. The various projects are planned by the several city departments, which also supervise them. A separate bureau of inspection has been set up by the state organization. The CWA furnishes part of the equipment and materials needed. Projects include the usual type of street and park work, repair and painting of public buildings and the repair of cemetery grounds.

Preparation of tax maps is employing 206 engineers. Traffic counts and service projects are giving work to many women. A city planning project is taking care of numerous draftsmen. On all projects under way the spirit of the workmen is high, and results obtained are about all that can be expected.

York, Pa., is undertaking a real construction job in the straightening out of Codorus Creek for a distance of 2½ miles through the city. This stream ran wild last August, doing millions of dollars of flood damage. Gannett, Seelye & Fleming, consulting engineers of Harrisburg, were retained by the city and county to work up plans for control of the creek. These plans were ready about the time the CWA program was started, and approval was secured for carrying them out as one single project. As a result, York has the distinction of being one of the few cities where CWA work is being directed by consulting engineers. The city and county share in the engineering expense and supply all tools, equipment and materials needed.

At present 3,000 men, four draglines and numerous teams are at work. A straight channel 220 ft. wide is being excavated through the creek valley, cutting out tortuous curves and eliminating choked channels. The draglines are doing the dirty work of excavating at points where the old and new channels coincide. Hand labor is being used to widen out the channel in places where the men can work mostly in the dry. Material is removed in wheelbarrows or in wagons, depending upon the length of haul. At the lower end of the project an industrial railway has been installed for removal of excavated material loaded by hand. About 470,000 cu.yd. of material will be handled. A portable saw mill supplies all timber and planking required.

The organization of the project consists of one superintendent and four assistants and two resident engineers. The resident engineers are assisted by an engineering staff selected from the registration lists. A foreman is provided for every 50 men. The laborers work on two five-hour shifts per day, six days a week. Production is fair, with most of the men really working hard. Unit costs are naturally high for this type of work. This project is taking care of about half the number employed on CWA work in York County.

Accomplishing its purpose

The Civil Works program is accomplishing its purpose in providing winter employment for millions who would otherwise be objects of charity. Results being secured in creating public works of lasting value are all that can be expected, considering the emergency nature of the program. Workers are giving substantial labor value in return for wages received. The CWA plan is not a construction plan, but an unemployment relief scheme. As such it has proved to be a decided success.

Roadside Advertising Regulated by New Law

As the culmination of several years of effort by various public bodies, a new California law regulates advertising signs along state highways for the purpose of promoting safety and protecting scenic beauty. The law provides (1) that there shall be no signs or advertising medium on state highway rights-of-way except official direction and information road signs; (2) no advertising structures or signs that obstruct vision and thereby provide a menace to safe driving are permitted; and (3) state control is provided for all advertising signs visible from state highways outside incorporated cities.

State control is provided by requiring the licensing of all firms or persons engaged in outdoor advertising and by establishing a system of permits and fees. The annual license fee is $50, with an additional permit fee of $1 for each advertising structure and 25c. for each sign. The law provides that signs and structures carry the name and permit number of the owner.

General provisions prohibit the erection of signs which are within the highway right-of-way; those that imitate stop, warning or danger signals, are located in drainage channels or are unsafe. In all cases the owner's permission must be obtained for the erection of any sign, and they will be prohibited if they are within 300 ft. of an intersection or if they obstruct the clear view.

Thin-Section Concrete Arches as Built in Switzerland

Flexible barrels designed to take direct thrust only while rigid and deep deck girders resist the unbalanced live-load moments

By M. S. Ketchum, Jr.
Urbana, Ill.

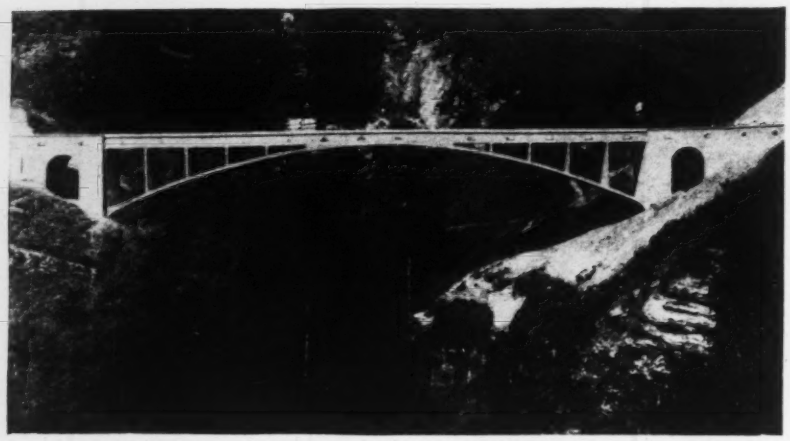


FIG. 1—FIRST THIN-ARCH concrete bridge was built near Andeer, Switzerland, in 1925. It is a highway structure of 140-ft. span, with a rib thickness of 9 to 11 in.

INVESTIGATION of the interaction between arch rib and deck in the reinforced concrete arch by means of models has shown that although the live-load stresses in the rib are considerably reduced by the stiffness of the deck, stresses in the superstructure are increased. At the present time mathematical analysis of these stresses, although possible, is out of the question for ordinary design. To get away from these uncertainties, R. Maillart, consulting engineer, Geneva, Switzerland, has built a number of reinforced concrete-arches, using a flexible rib with a stiffening girder. Although relatively unknown in this country, this type of bridge has been used in Europe for more than 40 years, chiefly for bridges of steel. As constructed in reinforced concrete, the arch rib and the posts are thin slabs with little flexural rigidity, while the deck is made very rigid by deep girders. The structural action is similar to that of a suspension bridge. The rib is assumed to take only direct thrust and the stiffening girder the unbalanced moments from live load. In addition to stiffening the rib the girders carry the floor slab and act as railings to protect the traffic. This type of bridge requires a minimum amount of material.

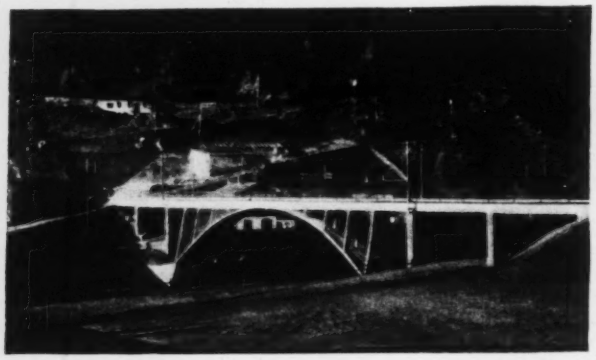
The Valtschiel Bridge (Fig. 1) near Andeer, built in 1925, was the first of this type to be designed by Maillart. It is a highway bridge with a span of 140 ft., a rise of 17 ft. and a roadway width of 10 ft. The depth of the stiffening girder is 3.6 ft., the thickness of the floor slab is 6.3 in., and the thickness of the rib slab varies from 9 in. at the crown to 11 in. at the abutment. The bridge was designed for a 7.7-ton truck and a uniform load of 61 lb. per sq.ft.

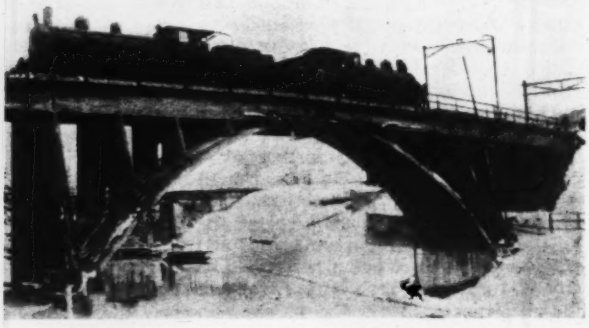
The Landquart Bridge at Kloster (Fig. 2) on the narrow-gage Rätisch Railroad has a total length, including approaches, of 246 ft. The arch span is 98 ft., and the rise 26 ft. The thickness of the rib slab varies from 10 in. at the crown to 13 in. at the springing and is laid on a polygon with straight lines between panel points rather than on a smooth curve. The most unusual feature is the fact that the deck lies on a curve of 410-ft. radius. A ballasted track is carried by a 12-in. floor slab between the stiffening girders. The outer girder is slightly superelevated to take care of the dynamic forces. A train at rest will load the abutments of the arch eccentrically, but the centrifugal force due to a moving train brings the resultant force nearer the center. The approach girders are not continuous with the stiffening girders, although they are of the same depth to preserve the lines. The longitudinal forces in the arch are taken by the rib at the crown from which they are transferred to the abutment through thrust in the rib and bending in the girder. This bridge is now three years old, is in excellent condition and has given good service.

As is customary in Europe, load tests were made on these bridges following construction. Loadings slightly in excess of the design loadings were moved over the bridge at varying speeds and measurements were made for deflection, vibration and unit deformations at important points. Deflections less than those calculated were recorded, and the structures were found to be free from excessive vibration.

In constructing this type of bridge, scaffolding is required to support the forms only during the pouring of the rib slab. Because the slab is thin, the scaffolding may be light. After the slab has set, the timbering, which rests on sand boxes, may be slightly lowered so that the weight due to the deck and the

FIG. 2—TWO VIEWS of a thin-arch railroad span of 98 ft. with a rib-crown thickness of only 10 in. The design was complicated by the fact that the bridge is on a 410-ft.-radius curve.





deck forms is taken by the rib as an arch, while the centering remains to protect the rib against excessive deflections due to unbalanced loads. At sites where the bridge is quite high above the stream, as is common in Switzerland, the use of lighter scaffolding may result in a considerable saving. Any saving effected in the amount of concrete used is probably offset by the higher quality required and the greater care needed in placing it in the forms.

About ten of these bridges have been built in Switzerland. Photographs and descriptions of these bridges were kindly furnished by Mr. Maillart and A. J. Bühler, chief engineer of bridges, Swiss State Railways. Further descriptions may be found in *Der Bauingenieur*, Vol. 12, 1931, p. 165.

Concrete Base Design for Crack Control

Crack survey and proposed methods of joint construction to control cracks in concrete base for bituminous pavements at Utica, N. Y.

By Guy C. DeWitt
Department of Engineering, Utica, N. Y.

EXCESSIVE transverse cracking in the pavements of Utica, N. Y., began to be noticeable a few years ago. This was probably about the time that snow removal on all streets became the practice. Many reasons were advanced as to cause, and it was at first thought that this cracking was peculiar to the city's construction methods. It was soon learned, however, that cracking in asphaltic-top pavements was not confined to this city.

In 1931 surveys and observations were started to determine the reason for this cracking. Greatest attention was given to those pavements constructed during the summer months. The standard pavement of asphaltic type for minor streets in this city is a 2-in. wearing surface on a 6-in. base of 1:3:6 concrete. Streets of this type without the complication of intersections offered better conditions for study. As a result of this study, which at best is incomplete, the following conclusions were reached:

1. Hair cracks in the concrete foundation, occurring at relatively close intervals (less than 35 ft.), did not carry through the pavement later on. With this mix of concrete, cracks occurring at these intervals indicate improper curing.

2. Cracks occurring at intervals a little greater than 35 ft. caused partial cracks in the pavement later on.

3. The interval between cracks in foundations known to be properly cured was found to be much greater. The next season it was found that these cracks in the base occurring at the greater interval did carry through the pavement and were very noticeable.

4. The width of crack is probably in direct proportion to the interval between cracks.

5. The location of cracks is determined by many factors. Mix, cement, amount of water, aggregates, subgrade friction, bond of curbing, diminished transverse section and construction joints all have a great influence on the formation of cracks, but greater than any of these is curing.

The cause of cracking in the foundation is shrinkage. The cause of cracking in the wearing surface is contraction of the foundation due to the lower temperatures of winter. At what temperature the wearing surface loses enough of its plasticity to crack is not known, but the penetration of the asphalt cement used should have some bearing on it. The top should have enough plasticity in warmer weather to heal the cracks somewhat.

It would appear that there might be a method of construction to prevent unsightly transverse cracking. One is by the use of contraction joints in the concrete foundation, installed at intervals of something less than 35 ft. The distance between joints should be determined by the temperature at the time of construction. No pavement should be laid on this foundation until it has had ample time to adjust itself after proper curing. The hair cracks that would occur at these contraction joints prior to placing the pavement should provide ample space to take care of any expansion that would occur. Whether or not there will be a breaking down of the pavement at these joints from the working of the foundation slab, due to temperature changes, is not known.

A second method would be the predetermination of contraction joints at greater distances apart. In this case the foundation should be reinforced by bars placed longitudinally only. The amount of steel required depends upon the distance desired between joints. These joints would have to be designd with pavement guards on a sliding plate or both.

In a pavement designed for construction this year, weakened-plane contraction joints were called for at 21-ft. intervals. This interval coincided with the jointing of the concrete curbing. These joints in the 7-in. foundation were to consist of metal strips 3½ in. in depth resting on the subgrade and supported by temporary bulkheads. They were to be set truly vertical to the plane of the pavement and would reduce the transverse section by half. It was believed that shrinkage cracks would occur at these joints but that they would be so small that the interlock between adjacent slabs would not be destroyed. It was hoped that by this method the transverse cracking would be eliminated to a great extent. Another type of pavement was designated, however, and no other opportunity has presented itself to try out this type of joint.

In another pavement now under construction it is planned to install in a certain section deformed contraction joints that will completely separate the slabs. These joits will be made of very light metal. A 500-ft. section will have joints spaced at 21 ft., and another section of the same length will have them spaced at 28 ft. It is planned to exercise careful supervision over this section, and it is believed that there will at least be no early cracking.

Reinforced-concrete highways have probably had the benefit of more engineering study and research than any other type of construction. Publications without number have covered all phases of design and construction. Without doubt there is enough known of the behavior of concrete in pavement foundations to provide at least tentative specifications for proper design. It would be well within the province of those national organizations interested in better highways, which have the means, to make necesary field or laboratory tests on which to base a specification.

Smaller cities usually lay a greater yardage of blacktop pavement than of reinforced concrete. Progress in design is made by trial and error. Individual and isolated studies cannot hope to accomplish as much as the concerted efforts of those who have the facilities with which to work. It is believed that the importance of concrete foundations not only for bituminous surfaces but for brick and block surfaces warrants further investigation of their design to reduce cracking.

Sewage Farming in New Jersey

The borough of Vineland, N. J., disposes of its sewage by irrigating a tract of coarse sand about 2½ miles from the borough. The cost of sewage disposal, exclusive of interest and depreciation on the plant, has been about 15c. per person. Many crops, including alfalfa, corn and other feed crops for livestock and poultry, have been grown successfully by using the sewage on the otherwise sterile sand. This information is contained in the report of the chief of the Bureau of Agricultural Engineering, for 1933, of the U. S. Department of Agriculture.

The Effect of Sewage on Cast-Iron Venturi Meters

By C. E. Keefer
Principal Assistant Engineer, Bureau of Sewers, Baltimore, Md.

THE BALTIMORE sewage-works is provided with five 42x21-in. cast-iron venturi meters, which record the flow of screened sewage preliminary to its treatment in settling tanks. As this meter installation is one of the oldest in this country, it was considered desirable to make an internal inspection of the meter tubes in order to determine to what extent the iron has been affected by the sewage flow.

The five meters were installed and ready for service in 1911. According to the specifications, the interior and the exterior of the meter tubes were to be "carefully painted with coal-tar varnish, applied hot and well rubbed in with a stiff brush." So far as can be determined, these specifications were followed. Three of the tubes were put in service in November, 1911, and have continued in operation up to the present time. The fourth meter was in intermittent use from 1915 to 1921, and the fifth has been in operation from 1921 to date. The sewage flowing through the meters is practically devoid of oxygen due to the long length of tributary outfall and intercepting sewers. Furthermore, as Baltimore is sewered on the separate system, there is comparatively little grit present. The velocity through the meters naturally varies from day to day and from year to year. The following are the approximate velocities, in feet per second, during the past ten years:

	Inlet	Throat
Average	4.0	16.0
Maximum	8.0	32.0
Minimum	2.0	8.0

Before the meters were opened for inspection, it was expected that there would be a considerable coating of solids or incrustation on the insides of the tubes. A careful examination of all the meters indicated, however, that they were perfectly clean and smooth on the inside. Furthermore, there was no indication that the cast iron had disintegrated. The surface of the iron was covered with a thin black film, somewhat similar to a coat of paint, that was no thicker than a sheet of paper. Each meter throat is provided with a bronze lining, the inside diameters of which were measured at several points and found to be 21 in., the diameter originally furnished. There was practically no offset between the inner faces of the bronze linings and the adjacent surfaces of the cast iron.

As judged by this investigation, it would seem that domestic sewage has little, if any, disintegrating effect on cast iron, provided the sewage is domestic in character, free of oxygen and gritty materials and not flowing at excessively high velocities. As these observations were made where the flows always filled the pipes, there no assurance that similar condition would have been found if the sewa had only partly filled the pipes and t iron surface had been alternately w and dry.

The sewage-works at Baltimore under the general supervision of B. I Crozier, chief engineer, department public works, and G. E. Finck, sewe age engineer, with G. K. Armelin superintendent.

New Timber-Concrete Beam Develops High Shear Value

TESTS of a new type of composite timber and concrete beam made at George Washington University, Washington, D. C., and reported by J. F. Seiler, engineer, American Wood Preservers' Association, in the November issue of *Wood Preserving News*, reveal that its special type of construction affords a high degree of efficiency in horizontal shear and in addition offers several advantages for bridge and wharf decks and heavy-duty floors. The tension portion of the beam—or slab, since it will seldom be used in conventional beam-and-girder construction—consists of vertical laminations of plank spiked or bolted together with their upper edges alternately stepped, forming grooves 2 in. deep. The compression portion consists of concrete poured on top of the timber slab. The outstanding feature of the design is the use of thin triangular metal plates, called "shear developers," that are driven into the longitudinal grooves at intervals. These shear developers, being supported on three sides, are more effective than types of shear keys which depend on cantilever action alone, such as the nails used formerly.

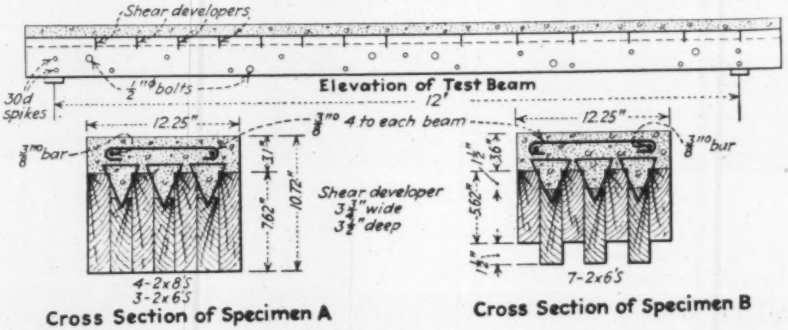
Among the advantages claimed for this type of construction are: (1) a size and grade of lumber is utilized that is low in cost compared with the size ordinarily required for stringers; (2) such thin planks as are suitable may be effectively and easily treated with preservatives; (3) the wood portion of the slab is adequately strong to support loads during construction and to serve as a form for the concrete topping; and (5) the design is suitable for continuous construction over piers or other supports.

The tests at George Washington University were concerned solely with determining the efficiency of the shear developers. It was found that their failure usually occurred in bending and that each shear developer would resist about 4,000 lb. It was concluded that in such composite wood-concrete beams the full strength of the homogeneous beam or slab may be developed by the use of these shear developers.

In installing shear developers they are placed at an angle of about 10 deg., to resist any tendency of the wood to separate from the concrete. Their direction is up and away from the supports, except in cases of continuous construction, where their reactions at the support may be reversed.

Inasmuch as the concrete is the effective means of load distribution, it is not necessary to use great care in fastening individual planks together. But the spikes or bolts should be located in the area well below the neutral axis.

TYPICAL DETAILS of test beams of composite timber-and-concrete construction, in which triangular pieces of steel are used to resist horizontal shear. The design contemplates the use of flat slabs rather than beams and girders.



The Great Paved Roads of the Mayan Civilization

BEFORE the tenth century, when central Yucatan was the home of the great civilization of the ancient Maya, paved roads of remarkably permanent construction connected the major centers of population and radiated out to the minor cities. The greatest of these roads was 62½ miles long, connecting the cities of Coba and Yaxuna. It has recently been explored by the Carnegie Institution archeologists who have in preparation for publication a complete report on their discoveries (*Bulletin*, Carnegie Institution, Sept. 24, 1933). Advance information gives the following account of the design and structure of the Coba-Yaxuna road, or causeway, now buried in the jungle growth covering the long-abandoned cities and structures of the Maya.

The road survey through the jungle was made in March of 1933, by Alphonso Villa, assistant to Prof. Robert Redfield, Chicago University, a research associate of Carnegie Institute, under the direction of Professor Redfield and Dr. Sylvanus G. Morley, Carnegie Institution.

Starting at the Yaxuna end the road was found to take off from a small pyramid at the center of a great number of mounds, originally structures of various types, which now, however, except for a single acropolis-like building (still standing but badly weathered) comprise all that is left of this one-time important city. Based on Villa's measurements, the road for 43 miles out of Yaxuna runs almost perfectly straight, and in the remaining 19½ miles its original direction changes but four times, and only slightly at that. In width, the road is from 30 to 34 ft.; in height, to which it is built up above the surface level of the terrain, it varies from 2 to 8 ft.

Method of road construction

In the construction of their roads the ancient engineers began by digging down to hardpan, which is near the surface, and erecting retaining walls on each side to the height to which they desired to bring the road. These walls were built of large, roughly faced limestone set in mortar. Into the space between the walls a layer of heavy boulders, some of them 2 or 3 ft. in length and weighing many hundreds of pounds, was carefully laid and the spaces between chinked with smaller stones fitted and hammered into position.

Other courses followed, each of successively smaller boulders and stones, quite as carefully placed, until the road had been brought to the requisite height, whereupon a layer of rock broken into much finer pieces was added. After this was hammered or rolled into a hard level surface, a fine coating of cement mortar was applied.

Great "white ways"

The modern Indian name of the ancient stone roads of Yucatan is *sacbe* (plural, *sacbeob*), which means, literally, "white road." The name is of remote origin; it is probable that it is the name the builders themselves used, although this is not certain. However this may be, the name is peculiarly expressive, for the surfacing coat of mortar cement that was applied was made of lime mixed with finely sifted white earth, called *sascab*, which originally, under the tropical sun, must have given the roads a dazzling appearance, quite as dazzling perhaps as the great white ways of our own cities.

Earl Morris, of the Carnegie Institution staff, who has studied the processes used by the Mayan builders who worked with stone, says that the *sascab*, or white earth, is a sort of breccia or conglomerate lying beneath the limestone caprock of the country, and that in ancient times it was mixed with slacked lime as masons with us today use sand. He adds that the miners burrowed for it wherever the digging was easiest and that the region around Chichen Itza is full of caves where it was dug, one of them being 20 ft. deep and large enough to shelter 200 people.

It was cement made in this way that was used to such good effect in temple construction, providing hard and durable coverings for the floors, and the fine-grained wall surfaces of glossy smoothness so suitable as backgrounds for the frescoes and murals with which the ancient artists adorned the walls. Morris states that in the old days, when there was less hurry, the masons took great pains in preparing the cement, stirring and remoistening it daily for many days, and, when applied, tamping it with wooden mauls for hours on end until it became as poreless and as compact as stone.

He also says that, when needed, the surface paste, as it was being tamped and finally troweled, was remoistened with a solution made by soaking the bark of the *chilom* tree in water. Given this treatment, the cement was not only rendered practically impervious to water but, under the trowel of the mason, it took on a magnificent polish.

Probable time of construction

Although evidence of the existence of these *sacbeob* has been found at a few points in the Yucatan Peninsula, nevertheless the Coba region is unique in the extent and elaborateness of its system of causeways. Sixteen of these raised roads, varying in length from a few miles to 62½ miles (the length of the Yaxuna-Coba road), terminate within the great body of ruins about the chain of lakes.

Harry E. D. Pollock, of the Institution staff, who has visited Coba three times in study of the ruins, commenting upon the time when these roads were built, says that it is highly improbable that work of such magnitude and representing such organized effort could have been accomplished in a late and decadent period of Mayan history. His study of the architectural features of the Coba ruins discloses evidence of two periods of construction, to the earlier of which belong the great majority of the structures; also, that the workers of the time had all the technical skill and knowledge that road construction demanded. In the absence of all evidence to the contrary, he concludes that it is best to consider the *sacbeob* as having been roughly contemporaneous with the structures of the earlier period.

One cannot be sure of dates when dealing with Mayan history, but there is much evidence to support the statement that at the middle of the fourth century A.D., the Coba region was occupied by an organized and established people who were capable of building these great causeways. It is probable that they were begun during this century and completed before the end of the seventh.

Built for men afoot

Why they were built is another mystery. The Maya had no beasts of burden, as had the roadbuilding Inca of Peru; nor wheeled vehicles, as had the Romans, the greatest roadbuilders of ancient times; yet in durability, in evidence of careful workmanship and in prodigious expenditure of labor in construction and upkeep the roads of Coba must have compared favorably with those of both. Apparently these highways were built for travelers afoot and for men bearing palanquins and carrying burdens upon their backs.

The first American road roller

It was while cutting his way through the thick bush, 22 miles out of Yaxuna, that Villa came upon a stone roller, which may fairly be called the first American road roller, lying on top of the causeway toward one side, in all probability just where it had been left by the builders centuries before. Sun and wind and weather and the passing years have treated it badly, for the shaft is broken in two nearly midway of its length. Moreover, segments of considerable size have flaked off, but enough remains to satisfy the observer that it had been quarried and given cylindrical shape for a purpose, the most plausible being that of use in road construction and road upkeep.

Subsistence-Homestead Program Started in West Virginia

THE FIRST of the ninety proposed federal government's subsistence-homesteading projects is being developed on a 1,100-acre farm near Reedsville, W. Va. The population will consist of something over 100 ex-coal miners who have not had steady employment for five years or more. Regular employment will be furnished in a factory to be erected by the Post Office Department for producing furniture to meet its peculiar requirements. At this occupation the men will earn about $1,000 per year, to be supplemented by tilling 5-acre plots around their homes.

In general, the federal government's program is intended to demonstrate the advantages of a "planned" community wherein the selection of sites, landscaping, house design and construction, availability of water and power supply, and transportation are vital elements. The ideal objective is to give the homesteaders more than one defense against unemployment, and the sites selected, therefore, will be located near towns and cities where the men have part or full-time employment at their trades or in rural districts where two or more industrial concerns can be induced to establish small plants. The controlling factors are cheap but fertile land and low-cost but sound construction that is attractive as well as utilitarian. The cost of individual home units, including land, is limited to a range of $2,300 to $3,000.

In the 90 projects now in view the home units will number from 25 to 200, with four to six rooms each. The design will be indigenous or appropriate to the locality, with sufficient variation to avoid monotony and preference to local materials when these serve economy and efficiency.

To date, loans have been approved on seven projects. Besides West Virginia, the states are New Jersey, Indiana, North Carolina, Ohio and Georgia.

The establishment and operation of each project will be in the hands of a local corporation, financed by the Federal Subsistence Homesteads Corp. out of a $25,000,000 appropriation by Congress. Each project will have its own architect and community planner, construction engineer and other technicians, but all plans, specifications and costs will be supervised by the parent corporation in Washington.

John Nolen, of Cambridge, Mass., landscape architect and city planner, has been retained in a consulting capacity. The corporation's staff will include a construction cost expert and probably an architect, engineer and materials man, but the board (of which M. L. Wilson is president) may decide to rely on consulting services.

Benjamin Gugler, New York architect, is designing the houses for the West Virginia project. Many of the prospective residents now are digging cellars as a means of creating an equity in the homes that will become their property under 20-year purchase contracts.

Federal funds will be advanced to the subsidiary local corporations at 4 per cent, to be amortized over a period of 30 years. The interest rate to the homesteader usually will be somewhat higher to cover management costs. Cash income to meet interest and amortization charges must be assured, but arrangements will be made, when necessary, for continuing relief to homesteaders until they can obtain employment. Loans will be made for tools, seeds, fertilizer and stock when not obtainable by the local corporation.

Although residents on the West Virginia project will have regular employment in producing furniture for the Post Office Department, the government, it is said, will not engage in industrial ventures on other projects. On the other hand, neither will it permit them to become mere "company towns." The basic idea behind the homesteading plan is revealed in the official prospectus which states that "the planned redistribution of population contemplated is essential in order that large groups of people, caught in a situation from which they are powerless to extricate themselves unaided, may have an opportunity to gain for themselves some degree of economic security and a more adequate standard of living."

Bridge Span Wrecked by Burning Gasoline Truck

By T. P. Blum
Bridge Engineer, King County, Wash.

ONE of the most peculiar bridge accidents on record occurred Dec. 10, 1933, near Snoqualmie, Wash., when a gasoline truck-trailer overturned and exploded as it started across a 220-ft. truss span. Before the fire burned itself out, two tension members were so badly damaged that one end of the span dropped into the Snoqualmie River.

The span is of Pratt type with inclined top chords, and carries state highway No. 2 on a 24-ft. roadway. Two 6-ft. wood-decked sidewalks are supported outside the trusses. The concrete road slab is 7 in. thick at the sides and 8¼ in. thick at the center, with 10-in.-high concrete curbs. Approaches at either end of the truss span consist of concrete deck structures 180 ft. long. The bridge, designed for standard H-20 loading, was built in 1931.

State highway No. 2 carries the bulk of truck and auto traffic between eastern and western Washington, and heavy transport trucks are common. The night of the accident a large gasoline truck of 6,000-gal. capacity approached the bridge from the west or Seattle side. The road slopes toward the bridge on about a 3 per cent grade with a curve to the right. Although most of the road is paved, this particular section, due to recent construction, had a road-mixed oil surface. Near the bridge the truck, turning and traveling at about 20 miles per hour, struck a chuck hole about 6 in. deep with its left front wheel. The impact blew out the tire, which ran off the rim. This bare rim, resting on the concrete approach deck, made the front end ungovernable. The truck started to whip and capsized the trailer. Gasoline, spilled from the breather cap of the truck, was set afire by the friction sparks from the trailer sliding on its side over the concrete deck. The flaming truck and trailer lodged against the first vertical hanger and first diagonal, both tension members. Because of the crowned roadway the flaming gasoline

BRIDGE OVER Snoqualmie River near Seattle, which collapsed as a result of a gasoline fire on its concrete deck.

ran to the curb, and a slight westerly wind blew the flames around the steel. As a climax, the truck exploded, but the driver, although badly burned, escaped.

The maximum temperature attained by the fire is estimated to have been about 1,300 deg. The resulting elongation unbalanced the loading and overstressed these members whose ultimate strength had been reduced about 75% by the heat. This caused the truss to collapse. The expansion end was the one that was burned, and this fell in the river. The fixed end remained on its pier, merely turning on the pins.

Traffic has been detoured to an adjacent King County bridge while repairs to the damaged bridge are being carried out under the direction of Lacey Murrow, state highway engineer.

Since the time of the accident, the flood conditions that have occurred in western Washington have caused much debris to be lodged against the side of the bridge, moving the fallen end about 75 ft. downstream. The four upstream anchor bolts on the fixed end have sheared, and the structure now rests on one corner of the pier, held by only one anchor bolt.

It is planned to build platforms on both sides and, after removal of the concrete deck, to raise the span to its original height. The fallen end will then be slid back to position. About 60 ft. of the damaged end will have to be renewed and the deck replaced. By reason of delay, if bids were called for, it was decided to do this work by day labor. The repairs are under the direction of George Shearer, state district engineer, with P. McRae as foreman. The estimated cost is $15,000, and the work is expected to require about two months.

Winter Concrete Paving on Ohio Municipal Project

By Harry C. Miller

Resident Division Deputy Director, Division 7, Ohio State Highway Department, Sidney, Ohio

TO ACCOMPLISH as much as possible in expending NRA federal highway funds to benefit unemployed labor, the Ohio state highway department has authorized construction by contract of a number of high-type paving projects, the work to be prosecuted during the winter of 1933-1934. One of these projects, located in Troy, Ohio, was awarded to contract on Oct. 27, 1933, with the stipulation that the work was to be completed by Jan. 1, 1934. This job consisted of the removal of rails and ties from an abandoned unpaved electric railway right-of-way, 20 ft. and 18 ft. wide, for a distance of 6,600 lin.ft., through the center of Market, Main and Elm Sts. and paving the area with concrete, brick and asphalt. U. S. Highway No. 25 is routed over these streets and carries 3,000 vehicles each 24 hours.

About 375 cu.yd. of concrete were used to replace the ties in the concrete base. High-early-strength portland cement was used for this concrete, as the prevailing weather was uncertain and low curing temperatures would retard the strength progression and jeopardize the quality of ordinary portland cement concrete so that a delay in the surfacing operations was liable to occur.

Immediately after the concrete for tie replacement was placed and floated to grade, the trough was covered with wet burlap and then spread with straw to a depth of 6 in. When the concrete had developed a flexural strength of 500 lb. per sq.in., as determined by breaking beam specimens cured with the concrete in the base slab, the curing and protection ceased and the surface of the pavement base was treated with an insulating course of bituminous material and fine stone chips.

Following this operation, a concrete surface course was placed on the base, having an average thickness of 6 in. This concrete was screeded and belted with a mechanical finishing machine, and the surface was brought to the grade of the adjacent concrete or brick pavement. Immediately after the finished pavement section was finished to grade and the surface dragged longitudinally with a burlap strip, the slab was covered with wet burlap and straw.

Test beams of the surfacing concrete cured with the slab disclosed that the 600-lb. flexural strength required before opening the new pavement section to traffic was obtained on an average in less than four days after the concrete was placed.

Of the 14,500 sq.yd. of asphalt, brick and concrete types of surface-pavement construction, approximately 9,500 sq.yd. was concrete. Both high-early-strength and ordinary portland cement concrete were placed for surfacing, the ordinary portland cement concrete being used when the weather conditions were such that the hazard of low atmospheric temperatures was slight. All concrete was placed at a temperature of about 70 deg. Both mixing water and aggregates were heated. The aggregates were batched by trucks to the 27 E. paver, and the cement was stockpiled.

The contractor, Davis & Hydaker, of Spencerville, Ohio, employed more than 150 men on this project during the life of the job, and all were furnished (with the exception of superintendents and clerks) by the local unit of the National Re-employment Service. Quality workmanship was secured and quality work was obtained on a class of construction that has been considered impracticable during cold weather. This was made possible largely by the use of high-early-strength portland cement.

This winter paving project was under the immediate supervision of division 7, Ohio state department of highways.

World's Developed Water Power Tabulated

THE developed water power in countries having an installed capacity in excess of 100,000 kw. is given in the accompanying table, which has been prepared by the American Committee of the World Power Conference under the chairmanship of O. C. Merrill, New York.

In giving out the figures, Mr. Merrill states that while every effort has been made to insure their accuracy, there may be errors, especially in countries having developments under 1,000,000 kw. Figures for the United States, Canada, Italy, France, Japan and Czechoslovakia are from official sources. Figures for Norway and Sweden are from data presented at the World Power Conference this year, and figures for Germany are taken from a detailed report prepared by the German Water Power Association. Russian figures were supplied by Hugh L. Cooper.

WATER-POWER DEVELOPMENT IN COUNTRIES HAVING AN INSTALLED CAPACITY IN EXCESS OF 100,000 KW.

Country	Kilowatts	Per Cent of Total
United States	11,800,000	30.06
Canada	5,256,000	13.39
Italy	4,348,000	11.08
Japan	3,151,000	8.03
France	2,781,000	7.08
Germany	2,300,000	5.86
Switzerland	1,900,000	4.84
Norway	1,850,000	4.71
Sweden	1,400,000	3.57
Spain	875,000	2.23
U.S.S.R.	758,000	1.93
Austria	725,000	1.85
Brazil	525,000	1.34
Finland	300,000	0.76
India	300,000	0.76
Mexico	235,000	0.60
Great Britain	228,000	0.58
New Zealand	225,000	0.57
Jugoslavia	190,000	0.48
Czechoslovakia	110,000	0.28
Total	39,257,000	100.00

The Public-Works Outlook Under the Budget

A statement of the federal administration's plans as revealed by budget data—Prospects in Congress are for change in distribution of public-works fund

Special Washington Correspondence

A CONTINUING PROGRAM of public works "to restore the face of nature," financed by an annual appropriation of $500,000,000, is proposed by President Roosevelt to follow immediately upon the present emergency program. In the fiscal year commencing July 1 this sum will be covered out of the new "recovery fund" of $2,000,000,000 which Congress has been requested to appropriate, but in subsequent years will be included in the balanced budget which the President hopes to be able to attain eighteen months from this time.

Public-works allotment not fixed

No definite provision is made in the new budget for carrying forward the emergency program of public works from now until the close of the present fiscal year. To cover additional "recovery expenditures" during this period, the President estimates that $1,166,000,000 is needed, but this has not been definitely earmarked, and public works are not included in the distribution regarded as probable. The probable expenditure includes $400,000,000 to carry the Civil Works program to its hoped-for termination by May 1.

Other large sums are intended to be applied to home financing, farm credit and gold buying.

Congress is expected to do some earmarking of its own with respect to public works, but the administration very evidently feels that a further appropriation is not necessary now in view of the fact that so little of the original outlay of $3,300,000,000 has moved into construction to date. The Budget Bureau estimates that disbursements by the Public Works Administration out of the original appropriation of $3,300,000,000 will reach $1,677,190,800 by July 1, and $1,089,883,100 more during the new fiscal year.

New PWA allotments, it is officially held, now would bring in work after the time when the emergency has passed. But without more funds now, PWA allotments for new projects must stop. And the $500,000,000 in sight for the new fiscal year, according to Administrator Ickes, would be largely absorbed for projects already authorized by PWA on which the original allotments were sufficient only to carry them for a year or eighteen months.

A continuing policy to be initiated

The President's long-range policy on public works is becoming well defined. It is the Roosevelt idea to achieve national planning and assure progress by putting public works on a pay-as-you-go basis at a fixed rate per year. This explains the emphasis put upon coordination of public-works projects by the National Planning Board and the instructions given to the Mississippi Valley Committee to formulate a national policy on flood control as well as to coordinate all presently proposed or authorized projects concerning flood control, navigation, irrigation and waterpower in the 32 states that comprise its immediate jurisdiction.

In years prior to the depression the average annual expenditure on federal public works ranged only from $250,000,000 to $350,000,000. Until late years this money could be spent only on projects individually specified by Congress. More recently the lump-sum method of appropriation was introduced, under which the annual appropriation could be expended on any project that had been placed on an authorized list by Congress.

The President disclaims any intention now of interfering with the prerogative of Congress to earmark the two-billion-dollar fund which he estimates as necessary in 1934-'35 "to prohibit the abrupt termination of the recovery program." But he looks for authority to shift funds from one item to another. He did not suggest in his budget message how the two-billion-dollar fund should be divided. From other utterances, however, it is known that a distribution is contemplated, roughly as follows: public works, $500,000,000; relief next winter, $600,000,000; Civilian Conservation Corps, $300,000,000; Reconstruction Finance Corporation, $500,000,000; farm credit and home-mortgage financing, $100,000,000.

Congress will have something to say

Aside from statutory allotments for naval construction, road building, etc., in the $3,300,000,000 appropriation for public works this year the President had practically complete discretion to distribute the fund where he wishe This distribution, now completed, being criticized by the returning Co gress on several grounds:

1. The claim is made that the fu was used to replenish budgets of perm nent government agencies deliberate curtailed by Congress at the last s sion, thus diverting money for ma purposes which Congress had refus to approve at that time.

2. Too large a part of the appropri tion has been allotted to feder projects.

3. The districts of many Congre men did not get what they regard a fair share. The upshot is a strong di position in Congress to take so money for public works, perhaps at th expense of civil works, and put it whe they want it. The President's well-lai plan for the future may consequentl be upset. He may also encounter oppo sition from those who think that en tirely too little has been provided fo public works and from those who thin there has been entirely too much.

Administrator Ickes went to considerable pains this week to refute criticism from the Capitol. With reference to the preponderance of federal projects he reminds Congress that a large percentage of the total was allotted in the law by Congress itself, and in defense of large allotments made for federal projects by PWA, he says that the primary purpose of the law was to put men to work. The federal agencies, he explained, were completely organized and their projects were planned, so that work could start almost immediately after allotments were made. At that time and for weeks afterward there were, according to Administrator Ickes, no non-federal projects before PWA; an organization had to be set up and "If we had withheld any considerable part of the fund specifically for non-federal projects, we would still be struggling with them."

"If we get new money," said Mr. Ickes, "a disproportionate part can go to non-federal projects, so in the end we will strike a balance between federal and non-federal work," Mr. Ickes says; but he has not stated clearly whether he wants a further appropriation. As for allotments made to federal departments for a wide variety of purposes for which the last session of Congress refused to appropriate, Mr. Ickes takes the position that the National Industrial Recovery Act (Title II) did not by its terms "negative" work which Congress felt at the time the law was enacted last June could not be covered in the ordinary budget. On this point he has said, "While Congress felt that it didn't have enough money to satisfy all departments, it passed the responsibility on to the President under the NIRA. I think when Congress looks into the situation, it will find a pretty good job done and be willing to trust the President with another appropriation."

Los Angeles Flood Damage Due to Torrential Rain

Downpour of 12 in. in 35 hours in fire-swept foothill area is responsible for floods that cost nearly 50 lives

BREAKING local rainfall records of more than half a century, the storm of Dec. 31 in the foothills behind Los Angeles resulted in tremendous floodflows through the northern suburbs which cost about 45 lives and millions of dollars in property damage. The intensity of the runoff and the volume of debris carried resulted from a combination of circumstances. About two weeks before the storm a heavy rainfall had saturated the catchment area behind the small towns of La Crescenta, La Canada and Montrose (a part of Glendale). Further, this same area had been completely denuded of brush and natural cover by a fire that swept through a large section of the hills during the fall.

Under these conditions it was practically inevitable that a precipitation of more than 12 in. in 35 hours and reaching an intensity of about 1 in. an hour would produce unprecedented floodflow and also would bring down a tremendous volume of silt and debris. The natural watercourses were poorly defined and had been restricted by building activities. It is important to note that in the Tujunga watershed, immediately to the north, where the storm had practically the same proportions, the flood-protection works of the Los Angeles County Flood Control District, including check dams and the Big Tujunga Reservoir, prevented what might have been far more extensive disaster.

For appreciation of the conditions affecting floodflow and the flood-control problems of Los Angeles County, an outline of the essential topographic and climatic facts is essential: To the south of Los Angeles extends a practically level plain about 10 to 15 miles to the ocean (see map). To the north and east, the suburbs and thickly populated areas extend up into the range of foothills, which, in turn, continue on into mountains with peaks reaching up to 6,000 ft. in elevation. The streams are all local and are practically completely contained in the county between the mountains and the ocean. To this topographic condition is added the fact that the region is typically semi-arid in climatic characteristics, with low average annual rainfall but subject to storms of cloudburst intensity, approaching those of a desert region, which at long and irregular intervals produce flash floods.

Weather Bureau figures on the rainfall of Dec. 30 and 31, and for the year, are given in the table on p. 52.

These conditions tend to promote the natural formation of wide flood washes, normally used only once a year, and still wider overflow channels used only occasionally, many years apart.

Reporting on the flood conditions and damage two days afterward, E. C. Eaton, chief engineer of the Los Angeles County Flood Control District, gives the following facts:

* * *

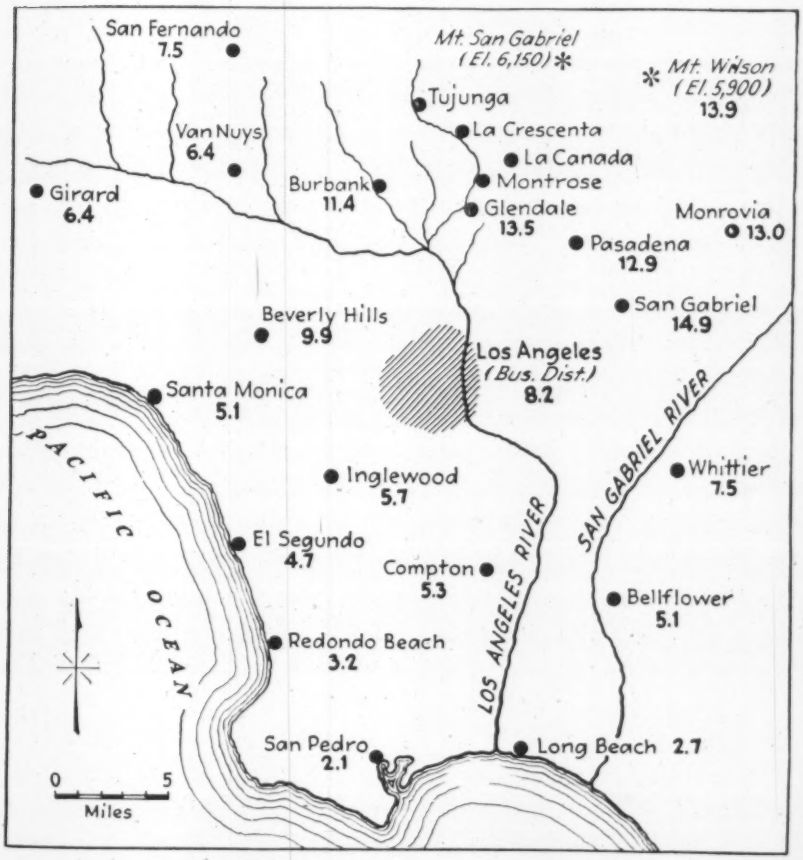
The disastrous results occurred from a flood originating in a small group of recently burned foothill watersheds totaling only 0.3 per cent of the district's total watersheds, and the major concentrated damage resulted from only two small watersheds totaling less than 3 square miles, or only 0.1 per cent of the watersheds.

In each instance where permanent types of protection works had been constructed, there was practically no damage to property in front of which the protection works had been built. While the heavy concentration of the storm was in the foothills and not the usual proportionately greater rainfall in the mountains, there was still a substantial mountain precipitation that was sufficient, had the watersheds been uncontrolled, to have caused damages far in excess of district total expenditures made where permanent types of works were built.

That the solution to the protection of lives and property in the areas immediately below the foothills is dependent upon the construction of adequate debris basins was strikingly proved in Haines Canyon, where its debris basin undoubtedly prevented a disaster similar to that in the Montrose area, and was also evidenced in the case of the partly completed Verdugo Basin, which saved much damage to Glendale.

The forest fire which commenced Nov. 21 and ended Nov. 24 burned off a total of fifteen marginal foothill watersheds—Haines Canyon, Bluegum, Blanchard, Cooks, Dunsmuir, Wards, Shields, Eagle, Goss, Pickens, Sumer, Webber, Winery, Hay and Gould. These ranged in size from Pickens, the largest, with a 1.6-square mile area, down to Webber, the smallest, with 0.15 square miles. The total of all fifteen is about 10 square miles, of wihch 7.6 square miles were totally denuded by fire. Haines Canyon, the most westerly,

SKETCH showing area affected during the 35-hour storm of Dec. 29-Jan. 1



AUTOMOBILES in the streets of Glendale caught in the floodwaters and partly buried in mud before their owners could get them out.

had about 50 per cent of its total area burned.

All of these watersheds have deltas where they discharge onto the lower sloping plains area with poorly defined (or undefined) watercourses below the mouths of the canyons, and successive streams in times past have shifted laterally their watercourses over broad areas. Most of these watersheds are tributary to Verdugo Wash; Bluegum and Haines are tributary to Big Tujunga Wash; Winery, Hay and Gould are tributary to the Arroyo Seco.

Many homes and towns have been built directly in the paths of previous stream channels, the heaviest concentrations of population and property values being Glendale, Montrose and Verdugo City, lying below Pickens and Halls Canyons near the easterly boundary of the burned area, and the city of Tujunga below Haines Canyon near the westerly limit of the burned area.

The slopes of these watersheds are steep, and the formations are loose disintegrated granite held in place by the natural growth of brush and small trees.

One foot of water in two days

In the foothills the storm commenced Dec. 29 about midnight and ended at 5 a.m., Jan. 1, a total of 53 hours. Minor showers occurred after this time but were relatively small.

This storm followed a previous storm commencing on Dec. 14 at 5 p.m. and ending on Dec. 15, totaling about 4 in. in the foothill area. The storm of Dec. 30 and Jan. 1 had an average total rainfall in this foothill territory of about 11½ in.

Results on a few recording rain gages gave intensities of 2 to 3½ in. in 5 hr. and 4 to 6 in. in 9 hr. On the Flintridge gage in three consecutive hours the total was 3.22 in.

The storm concentrated in the foothill areas, the mountains not having the usual proportional increase in precipitation as compared to the valleys. The measured precipitation at Opids Camp rainfall station in the west fork of the San Gabriel (El. 4480) showed 17.93 in. total as compared with 11½ in. in the foothills. The usual relation is two to four times as much rainfall in the mountains as in the valleys.

A SECTION of Montrose, showing some of the debris washed into the town from the hills.

RECORD OF RAINFALL DURING STORM AND COMPARISON OF 1933 AND 1932 SEASONS

	Storm (Approx. 35 Hours) in.	Season to Date 1933 in.	1932 in.
Los Angeles	8.3	12.0	2.0
Bellflower	5.1	7.2	2.3
Beverly Hills	9.9	14.9	2.0
Burbank	11.4	13.4	1.2
Compton	5.3	7.5	2.6
El Segundo	4.7	7.1	2.4
Girard	6.4	8.3	1.2
Glendale	13.4	17.6	1.6
Long Beach	2.7	4.5	3.4
Monrovia	13.0	17.4	2.5
Mt. Wilson	13.9	20.0	1.8
Pasadena	12.9	17.2	2.1
Redondo Beach	3.2	5.2	2.2
San Fernando	7.5	10.6	1.7
San Gabriel	14.9	18.8	2.3
San Pedro	2.1	3.5	2.0
Santa Monica	5.1	8.9	1.2
Van Nuys	6.4	8.4	1.5
Whittier	7.5	11.1	4.9

Debris flow and resulting damage

The heavy precipitation of Dec. 31 and Jan. 1, coming close after the previous rains of Dec. 14, quickly saturated the loose material on the totally denuded watersheds to the extent that sheet erosion occurred. Large side-hill masses slipped into the channels. It is probable that temporary damming of the mountain channels resulted and walls of debris and water 6 to 20 ft. in height issued from the canyon mouths, carrying many 5-ton rocks and a few of 10 tons or more.

These debris flows, widened and flattened to about 4 ft. in height as they passed through the populated valley areas and followed by swiftly moving streams of muddy water with smaller rocks and sand, cut channels as deep as 12 ft. or more. Pickens Canyon, having a poorly defined watercourse, tore its way down over the general location of its watercourse and spread more than 300 ft. wide. Halls Canyon divided just below Michigan Ave., about one-half the water and debris flowing down Ocean View Boulevard through the center of Montrose and over an area about 400 ft. wide, while the reduced an observed 10-ft. wall of debris maining half passed southeasterly through the city of Montrose.

Both Pickens and Halls Canyons' waters and debris entered the Verdugo Debris Basin and deposited the portion of their debris which had not been deposited on the streets and among the houses.

While recovery of bodies is still being undertaken, the known loss of life is now 39 with 45 missing. About 198 houses were demolished and 401 houses damaged to the extent of being unlivable, according to records of the county health officer.

Preliminary estimates give 50,000 cu.yd. of debris accumulated in the partly constructed Verdugo Debris Basin, and 500,000 cu.yd. deposited onto the Verdugo Cone, from Halls Canyon on the east to Blanchard Canyon on the west, extending down to the debris basin. This represents an erosion of about 50,000 yd. per square mile of foothill watershed, equivalent to about one twentieth of a foot erosion over the watershed area.

TYPICAL PEAK FLOWS ON MAIN RIVERS

Stream	Location	Time	Peak Flow, Sec.-Ft.
San Gabriel River	Dam No. 1	Jan. 1, 3:30 a.m.	18,000
Los Angeles River	Figueroa St., Los Angeles	Jan. 1, 4 a.m.	20,000
Ballona Creek	Centinella Blvd.	Jan. 1, 3 a.m.	15,000

Haines Canyon, with a total watershed of 1.3 square miles, of which about one-half was burned in November, 1933, pro-in the canyon, which avalanched into the debris basin, where it deposited 50,000 yd. of debris. This deposition protected Tujunga. The debris produced would have been greater had the entire watershed been burned.

Record floodflows

While the concentration of damage was in the burned area, large streamflows throughout the county resulted in scattered damage. In no case where permanent types of protection works were installed was serious damage experienced, however. Of the district's 518 miles of main channels only 15 per cent has permanent protection work. Where dams had been built, these operated to regulate floodflows.

Ballona Creek is outstanding as having a peak of over double that of any previous record. Its watershed totals 130 square miles, much of it draining paved streets and buildings, stormwaters from which pass into Ballona Creek. This creek (total length, about 10 miles) has only 1,500 ft. of permanent channel work, with no outlet to the ocean on the lower 4,000 ft.

Nearly all of the channels whose watersheds originate in the valleys or foothills produced peak flows in excess of anything on record, but the larger rivers (fed from mountain watersheds) did not have a peak of more than half that of record.

San Gabriel dams

San Gabriel rockfill dam No. 2 is now 90 per cent completed. Valves were blocked open, and the water rose a maximum of 47 ft. Floodflow estimated at 3,000 sec.-ft. passed through the 15-ft. outlet tunnel. Besides the destruction of the 8-mile construction road to the site, no damage occurred.

San Gabriel rockfill dam No. 1 is 10 per cent completed. A floodflow estimated at between 18,000 to 20,000 sec.-ft. was diverted by the cofferdam and filled the 30-ft. concrete-lined tunnel to within 5 ft. of the top at the intake and to within 10 ft. of the top at the outlet, successfully carrying the flow. Beyond inconvenience and delays no damage occurred. The newly constructed 10-mile road up the San Gabriel Canyon was blocked by slides.

* * *

Flood-control plans for the foothill region date back many years, but only part of the contemplated construction has been completed. A joint factor with the flood danger is the value of the water, which makes conservation as important as control. The basis of the Los Angeles County Flood Control District's program is the construction of a series of regulating and storage reservoirs in the mountains, to be operated in conjunction with spreading grounds where the streams leave the foothills, to put the excess water underground into the gravel beds. Extensive channel improvements are included in the program.

Work on the undertaking has been in progress for a number of years. The Big Tujunga Reservoir is part of the completed construction, but operations in recent years have largely centered in the San Gabriel Canyon, where two large flood-control dams are under construction (new No. 1 just begun, No. 2 nearly completed). The district applied several months ago for $30,000,000 of PWA financing in order to complete its project.

Determining Silt Content in Concrete Aggregates

By D. T. M. Davis

Texas State Highway Department, Childress, Tex.

THE DETERMINATION of the percentage of silt in concrete aggregates is often of importance to the field engineer responsible for the placing of high-grade concrete. The method outlined here is quick, easy and accurate and is adaptable alike to permanent laboratories or to field work where water-cement-ratio methods are used. The apparatus consists of the following: A torsion balance of 5,000-gr. capacity, and sensitive to ½ gr.; a pycnometer of approximately 1 qt. capacity, a satisfactory form of which consists of an ordinary quart mason jar fitted with a brass or aluminum top of conical shape; a 200-mesh sieve is also required.

The specific gravity of the material to be tested must be known and may be determined as follows. Fill the pycnometer with clean water at about 70 deg. F. with cap in place, and weigh. Match marks should be made on the cap and jar so that the cap may be screwed to the same position in subsequent weighings and constant volume thus maintained. A 1,000-gr. sample of the material to be tested, which has stood in the air until it is in a saturated surface-dry condition, is then weighed out in the tared pycnometer jar. Water is then added to the jar and sample, the conical cap is screwed on to the same position as before, and the whole is rotated until all entrained air is expelled. More water is added to fill the pycnometer completely, which is then wiped dry with a towel and weighed. The specific gravity is calculated from the following equation:

$$G_s = \frac{S}{(P + S) - W}$$

in which G_s = specific gravity, S = weight of the sample in grams, P = weight of the pycnometer plus sufficient water to fill, and W = weight of the pycnometer plus sample and sufficient water to fill.

Knowing the specific gravity of the material, the silt content is determined as follows. Weigh out in the tared pycnometer jar 1,000 gr. of the moist material and fill with water. With cap in place as before, rotate to remove all air bubbles, complete filling with water and weigh. Calling this weight W_1, the dry weight of the sample is arrived at by calculating the per cent moisture content as follows:

$$\text{Moisture} = \frac{100}{S}(W - W_1)\frac{G_s}{G_s - 1}$$

Having thus determined the dry weight of the sample, remove the jar from the balance and, while holding it above a 200-mesh sieve, remove the top and decant the supernatant water through the sieve. Refill to the top of the jar with clean water, replace top and shake vigorously for a few seconds. Return jar to upright position, remove top and, having allowed solids 15 sec. to settle, decant the wash water as before, taking care not to pour out any sand on to the sieve. Repeat this washing and decanting until the washwater is clear. Any sand that may have been poured out with the washwater is returned to the jar by holding the sieve over the jar and pouring water on the bottom side of the sieve. The jar, with top in place, is now completely filled with water once more, wiped off and reweighed. Calling this weight after washing W_2, the percentage of silt removed may be calculated from the following formula:

$$\text{Silt} = (W_1 - W_2)\frac{G_s}{G_s - 1} \times \frac{100}{(S - \text{wt. of moisture})}$$

On large jobs where the material is coming from one source the specific gravity need be determined only once; and if moisture tests are being made by the pycnometer method, the same sample may be used in making the silt test. A further refinement may be applied to the final formula by determining the specific gravity of the silt common to the pit by taking a sample from the overburden or other convenient source and substituting this value for G_s in the formula for silt content. However, since this value is used as a ratio, the error by using the specific gravity of the aggregate is negligible.

ENGINEERING NEWS-RECORD

Volume 112, No. 2

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Editorial and Publishing Offices at 330 West 42d Street, New York

January 11, 1934

Recovery Work to Continue

IN FRANK and vigorous manner the President's budget message has given an account of recovery costs and at the same time made clear that the campaign to reconstruct the country's economic life through employment will continue. The message was confident in its tone, and confidence-inspiring in its effect. It is a reaffirmation of the employment plan, of the public-works plan for which this journal long has stood. The program outlined by the message constitutes assurance that what has already been done in creating construction employment will be made fully effective; without continuance of public-works construction the scattered and slow enterprises so far initiated might fail of producing a sufficiently powerful invigorating effect on business and industry. But, in addition, the program furnishes to industry a strong, tangible reason for going ahead with new initiative of its own. Thus it gives double furtherance to continuing the economic revival that has been so well started. That the program makes a compelling claim for the active support of the entire country needs no emphasis. But it constitutes a special call to the states, cities and other public bodies to join in the national government's herculean effort to bring about full recovery through full employment. The effort can reach entire success only if all these public authorities do their part. Towns and cities that shirk the burden, that discontinue their own construction operations to depend on civil works gratuities, that ask the federal government not only to employ their idle workers but also to build their local improvements as a national contribution, make the success of the recovery campaign more difficult. The economic recovery that is now progressing requires that all work together to the same end, in order that full production capacity may be returned to regular operation at the earliest moment.

Healing Old Sores

MANY OLD SORES in municipal sanitation are in line for remedy in the long list of recent allotments to cities announced by the PWA. New York's refuse-disposal problem, which had occasioned the protests of a neighboring state and the intervention of the Supreme Court, now appears ready for rational solution through the approval of an advance of $4,000,000 for incinerator construction. Chicago's campaign for sewage treatment, likewise the object of attention by sister states and judgment by the Supreme Court, will be given invaluable aid by the $42,000,000 now made available. St. Paul and Minneapolis, where a start has recently been made in resolving the difficulties of providing adequate sewerage and sewage-treatment facilities by creating a new inclusive metropolitan sewerage district, are to have an $18,000,000 loan for the purpose. And there are numerous other allotments that make possible the cleansing of the waters adjacent to our major population centers. All this is of the utmost benefit. When to the economic benefits of increased employment and capital investment is added the social profit of improved public health, the public-works program is at its best.

A Look Backward

CONCEIT in modern invention receives a salutary check when we contemplate the achievements of the ancients such as the Mayan highway described in this issue, or the caisson work of prehistoric Egyptians described a few weeks ago. As an example of true scientific reasoning applied to the solution of a difficult engineering problem, the caissons devised forty centuries ago by the engineers who wrought for a forgotten Pharaoh undoubtedly rank first. The Mayan roads, or rather causeways—for the land of the Maya was a wet land—were more obvious applications of a construction art that had been developed in building their palaces and temples and in which many other far older civilizations had been equally proficient. Structurally, however, the Mayan roads were magnificent, and it is not the least of their interest that they embodied all the elements that twelve centuries later were developed by Telford and Macadam and even had the cement surfacing that is one of the improvements of which roadbuilding today speaks with pride. It is perhaps not unneedful to remind ourselves that these roads were hand-built, for the Mayans did not possess even draft animals; to remember that most of the things which man can build are capable of being built by hand, and that our use of machines is a wise expediency more than a necessity. But the Mayan culture was primitive, wonderful as some of its products were. It could not progress farther until metal tools and their resultants, the machine, had reduced human toil and made civilized life possible.

Thin Arch or Thick?

DIVISION of function between separate structural elements has always been an objective that fascinated engineers. Its merits have been discussed at great length, and the verdict appears to be various, depending on the specific case. In suspension bridges the separate cable and stiffening truss receive preference over the composite member, the braced cable. In abutments and retaining-walls the solid wall is preferred over the subdivided structure composed of wall slabs and thrust-resisting piers or buttresses. Which of these precedents shall be applied to the arch, where the effort to distribute function again appears in the interesting thin-rib arch bridges built by Maillet, as recounted on another page? These represent the exact analogue of the standard form of suspension bridge—linear member to take pure thrust and stiffening member to absorb moment. But there is a difference: In the arch the integrity of the stiffening girder is vital to stability, in the suspension bridge it is not, and thus in the former the subdivision of function introduces a new hazard from which the conventional single-unit arch is free. Generally, complete segregation of function appears to have merits and weaknesses similar to those connected with static determinacy in frames. And in this sense the composite or constrained structure is to be rated as stronger and safer but less adaptable. Where adaptability becomes itself an element of strength or safety the subdivided structure has the advantage; in other cases it is inferior.

What the CWA Is Doing

AFTER less than two months' operation, appraisal or even mere description of the Civil Works Administration's undertaking must necessarily be imperfect. Yet there are important reasons why this new agency for fighting the depression should be studied.

It is the largest employment-producing enterprise that has been set in motion. In its objectives it parallels the PWA, but its methods are far different. It is costing the taxpayer more in three months than the great emergency highway-building program will cost in one and a half years. What is gained through this prodigious expenditure? If the CWA program deserves to be continued, so basic a question demands answer.

And there are other important questions: Does the CWA work conflict with the PWA? Does it stimulate or deaden local initiative? Does it help industry to recover, or is it a mere relief device? A survey of representative Civil Works operations helps to provide answers.

The CWA has accomplished its purpose of putting four million men to work within six weeks. It is a successful relief device. Men are given real jobs and cash wages in place of grocery orders and rent money with or without the thin disguise of relief work. It is relief from the bottom up, however—and not very far up. The unemployed laborer is helped, the unemployed brain-worker in general is not. It falls far short of constituting a complete relief agency.

Speed considered, the work is well organized. Though administration is generally by relief organizations, planning and direction of work by engineers assure reasonably good selection of projects and fair execution. Further, most of the work is useful; much of it is truly productive of lasting betterments; some of it is made or waste work. On the whole its character entitles it to unexpectedly high rating.

From the standpoint of construction, on the other hand, the system is less excellent. It is inefficient. Hand-labor methods and overloaded gangs are not favorable to economy. Unit costs are high. Obviously such methods are not the way to carry on public-works construction. Further, since the plan is a relief plan, it does little for recovery, as it does not set in motion normal industry. A minimum of materials and tools is used, equipment that is indispenssable is rented where possible. While the workers and the necessity industries are benefited, the remainder of the country is left to itself.

There is conflict with the field of the PWA. Contrary to its originally stated intention, the CWA has taken up much work of normal construction type, by that much depriving regular construction workers of job opportunities. And this effect is supplemented by the results of the fact that opportunity for obtaining Civil Works construction without cost to the local community does not stimulate local initiative but leads to abandonment of normal construction work and acceptance of Civil Works construction in its place.

In sum, the system is clearly a stopgap—an emergency device that is doing a splendid job of human salvage but, like the charity-organization woodyard, is a regrettable emergency device. It has surely saved and reclaimed men; it has probably not helped recovery. Though it works at great cost, it is desirable and essential for the moment, but it must quickly be replaced by something better. The true opportunity for combining employment with reinvigoration of industry lies in the Public Works plan, and the sooner this is speeded up to such pace as will allow the wasteful CWA to be discontinued the more rapidly will the nation advance toward recovery.

Flood Danger and Apathy

WITH relentless certainty nature continues to repeat the age-old object lesson of disastrous floods and their toll of lives and property. With almost equal certainty the years that intervene between these visitations exert their soporific effect on public demand for protection, an effect almost impossible to overcome by mere recital of past records and engineering prediction of great but necessarily indefinite future havoc. Thus, after eighteen years without a serious flood in southern California, a storm struck the foothills behind Los Angeles two weeks ago breaking the records of half a century's rainfall and producing debris-laden flood waves that left death and destruction in their path.

That much of the catchment area where the storm centered had been fireswept only recently, and two weeks ago had been saturated by a heavy rain, was an unfortunate coincidence that added to the intensity of the catastrophe, but the occurrence of the flood cannot be attributed to these chance happenings. There would have been death and destruction without the fire and without the mid-December rain, and only flood-control works could have given protection. The fact that existing control works reduced the damage on adjacent watersheds is convincing demonstration of the only means by which safety can be attained. Now, after the event, this demonstration may bring about what should have been done years ago, namely insistence on immediate execution of the long-planned control program.

It is notorious that continued efforts of engineers throughout the country to impress the public with the inevitableness of flood recurrence are given little heed. Too often their warnings are overlooked even while the losses are yet being counted. Flood-control problems confront the majority of communities throughout the country. Fortunately, the lessons learned can be more widely utilized in far-distant sections of the country than those from most other natural phenomena. Many flood control plans should be definitely stimulated and advanced by the information on the most recent disaster, outlined by E. C. Eaton in this issue. Although there should be a proper regard for economic factors in even the most urgent flood-protection plans, yet the fact that human life and security are involved dictates more liberal provision for future contingencies than is required in other engineering plans.

Complete regulation of flood flow is rarely possible within due financial limits, nor is it often necessary. Proper study will soon show the logical balance, however. Engineering analysis is able to tell whether restriction of encroachment on stream channels is essential, whether artificial channels should be built, or whether detention storage must be provided. Each expedient has its place. But it is well for the public everywhere to appreciate that encroachment on streams by human works is one of the most prolific contributing causes of flood destruction. So at Los Angeles the encroachments made during the last decade on the natural overflow channels of the streams added greatly to the flood hazard and contributed to the deaths and losses of New Year's eve.

CURRENT NEWS

No New Funds for Public Works in Federal Budget

NO further appropriations for public works during the remainder of the current fiscal year are included in the budget recently submitted to Congress by the President. Thus the initiation of any further expenditures for such projects will have to come from Congress rather than from the President at a time when attention is centered upon the mounting public debt.

Status of the PWA fund

First complete report of the status of public works as of Dec. 30, is as follows: Federal projects, allotments, $1,370,988,136; construction contracts awarded, $546,788,186; estimated cost of day labor work started, $174,794,798; estimated cost of work being advertised, $127,321,593; non-federal projects, excluding railroads' allotments, $621,000,000; non-federal construction contracts and force account work started, $59,292,578; estimated cost of work being advertised, $51,915,283; railroad allotments, $211,000,000, and bids advertised, $112,283,000.

Of the larger items on the federal list, Navy vessels' allotments, $238,000,000; contracts let, $124,659,672; day labor work started, $84,709,440; bids advertised, $2,791,899; rivers and harbors allotments, $178,777,908; contracts let, $100,700,000; day labor work started, $5,350,000; bids advertised, $10,480,000; road allotments, $405,015,000; contracts let, $223,611,000; day labor work started, $15,704,000; bids advertised, $46,474,000.

In a drive to force prompt action on projects for which allotments have been made, Secretary Ickes has notified 84 applicants to whom contracts and grant agreements were sent by the PWA prior to Dec. 1, that unless such contracts are properly executed, signed and received in Washington within ten days from Jan. 3, the date of his letter, the loan and grant covered by contracts will be rescinded. Secretary Ickes also warned applicants that the mere act of signing contracts will not serve indefinitely to impound money. "Spring is on the way," said Mr. Ickes, "and weather conditions soon will permit construction work in every section of the country. If work does not start we will rescind allotments and award money to other projects. Our allotments were made to create work, not excuses and explanations of why work was not created."

Secretary Ickes denies persistent reports that PWA housing and slum clearance program will be abandoned. He asserts that there has been no change in policy but it is understood that President Roosevelt is very much disappointed. He regards $5 a room as the maximum rental that will accomplish the purpose of the program and PWA experience so far has demonstrated that costs cannot be held down to this figure.

Highway Advisory Council To Meet with Road Builders

The National Highway Advisory Council, an organization made up of representatives of affiliated organizations and divisions of the American Road Builders Association, will meet in Chicago during the week of Jan. 22-27 at the time of the annual convention and exhibit of the American Road Builders Association. The council will take up discussion of a code covering the highway industry, the continued financing of the program of the American Road Builers Association, including the source and distribution of funds, and the extent to which the federal government should participate in future highway development.

The county highway officials' division and city officials' division of the A.R.B.A. will hold special sessions during the same week, as has been customary in the past. The highway contractors, who formerly were represented in the highway section, will become part of the many affiliations recently extended and will form a regular section of their own with their own officers. This has been made necessary by the ever-increasing problems of the highway contractors, according to the association, and the demand that these problems should be met by those completely within this branch of the industry.

The Road Builders' exhibit will be held during the convention in the exhibition hall of the Stevens Hotel. This will be the first time in many years that the annual Road Show has been housed under the same roof as the convention.

Bristol, R. I., Votes to Complete Independent Sewage Plant

Largely on the ground that the cost of participating in the proposed metropolitan sewage disposal plan for upper Narragansett Bay municipalities in Rhode Island would be double that of independent handling and treatment, citizens of Bristol, R. I., voted on Dec. 28 to complete the local program now under way by accepting a PWA loan and grant of $200,000 for which all the preliminaries have been settled. H. K. Barrows, consulting engineer, Boston, Mass., investigated the comparative costs of the two schemes for the town. He pointed out that adherence to the metropolitan plan would entail annual outlays ranging from $35,000 to $60,000, depending on whether Providence adhered to the project. Prof. Barrows estimated that the annual cost of developing and operating the local system would be $17,000 during the 30-year period required to extinguish the investment, after which the system would be paid for and could be operated for about $7,000 per year. The proposed town treatment plant provides for coarse screening, sedimentation and chlorination. A pumping station will be required in the local plan as well as in the metropolitan scheme. It is estimated that the completion of the independent plan will provide employment for 130 men for eight months.

Non-Federal Loan of $124,000,000 Approved by PWA

FIVE HUNDRED and fifty non-federal projects for which loans, combined loans and grants or grants had been requested were approved by the Public Works Administration during the past week. The money involved in these commitments totals $124,257,000 and brings the number of non-federal projects approved by the PWA to 1,849 and the total amount of money involved to $832,667,000.

Instead of two lists totalling in the neighborhood of 100 projects, the normal PWA approvals during recent weeks, eight lists were given out. Seven of these lists covering 408 projects are given in the tables reproduced on pages 58 and 59. The remaining list of 142 projects announced Jan. 7 will be published next week.

Many small projects

A notable fact about the lists announced last week is that the great majority of the projects are small and are widely scattered over the country. They include a large number of water supplies and sewage disposal plants and many school buildings.

Larger projects

Included among the larger projects is $1,773,000 to the city of Columbus, Ohio, for twelve relief sanitary sewers; $2,500,000 to the city of New York for a large school in Bayside; $18,480,000 to San Francisco for improvement of its water supply and sewerage system; $1,159,000 to the East St. Louis Park District for park work and recreational facilities; $918,000 to Orange County, Calif., for harbor improvements; $1,060,000 to Muncie, Ind., for sewers and a sewage treatment plant; $626,000 to Salt Lake City for school construction, and $800,000 for a high school at Dobbs Ferry, N. Y. The principal loans and grants to San Francisco are made in place of grants of $2,695,000 and of $545,000 authorized some time ago when it was anticipated that the city would be able to raise the remainder of the money required through private sale of its bonds. However, as satisfactory bids were not received the city now seeks to obtain all the money from the PWA through a combined loan and grant.

Parker Dam on the Colorado

A loan and grant of $2,000,000 has been authorized to the Metropolitan Water District of Southern California for the construction of the Parker Dam on the Colorado River as part of its water supply project. Construction of the aqueduct from the dam to the Metropolitan District is under way. A sum of $760,000 has been allotted to Georgetown County, South Carolina, for a highway toll bridge over the Pee Dee and Waccamaw rivers; $552,000 has been allotted to the St. Francis Levee District in Arkansas for levee work along the Mississippi River; $1,150,-

000 to Gulfport, Miss., for a wharf and warehouse with cold storage facilities; $1,066,000 to Virginia Agricultural and Mechanical College and Polytechnic Institute, Blacksburg, for water storage and softening facilities and extension of the sewer system and building construction; $700,000 to Moberly, Mo., for additions to its municipal electric light plant; $1,250,000 to the Augusta Canal Commission, Augusta, Ga., for the construction of a hydro-electric plant; $1,600,000 to the Hueneme Dock Corp. (a private corporation yet to be formed), Hueneme, Calif., for harbor work estimated to cost $2,500,000; $950,000 to Denver, Colo., for improvements to the waterworks system; $756,000 to Racine, Wis., for sewers and a sewage treatment plant; and $2,000,000 to Boston for two large schools.

Twin Cities sewage disposal

In the long list of projects announced on Jan. 7 were two combined loans and grants totalling $18,000,000 to the cities of Minneapolis and St. Paul for the construction of intercepting sewers and a new treatment plant. This money is to finance the work of the recently organized sanitary district. The city of San Francisco was allotted $3,500,000 to increase the height of O'Shaughnessy Dam on the Tuolumne River (included in the total previously noted); and the state of Oregon was allotted $4,392,000 for bridges, one over Coos Bay, one over Yaquina Bay, one over the Siuslaw River and one over the Umpqua River.

Los Angeles Schools

The Board of Education of Los Angeles, Calif., has been allotted $9,380,000 for the repair and strengthening or replacement of buildings of about 130 school plants, estimated to cost over $10,000,000. Many school buildings were condemned as unsafe following the recent earthquake.

Loans rescinded

The Public Works Administration has rescinded six proposed loans totalling $20,897,000 and has made reductions in three allotments amounting to $15,010,000. The principal loans rescinded were $11,700,000 to Sacramento for water supply and $7,895,700 to San Francisco for various construction projects. In both cases the applicants requested the loan to be rescinded.

Federal construction

Included among the federal projects to be financed out of the PWA funds is $2,944,000 to the Treasury Department for six buildings, the two largest items being $1,525,000 for a federal building at San Antonio, Tex., and $870,000 for extensions to the Customhouse at Denver. The Bureau of Yards and Docks of the Navy Department received $1,400,000 for radio communication facilities at Pearl Harbor, Hawaii, and at Summit, Canal Zone. The bureau also received $100,000 to add to the $2,250,000 already set aside for the naval hospital at Philadelphia. The office of National Parks has been allotted $705,494 for construction and improvements scattered over 12 projects, and the National Advisory Committee for Aeronautics has been allotted $478,300 for the construction of a full-speed wind tunnel at Langley Field, Va., capable of producing air speeds up to 500 miles an hour.

Gas Tax Increase in Missouri Not to be Put to Popular Vote

An increase in the gasoline tax in Missouri from 2 cents to 3 cents a gallon for school and general revenue purposes, proposed to be put to popular vote by a resolution passed by the Missouri Senate, as noted in our issue of December 28, page 795, was rejected unanimously by the constitutional amendment committee of the House of Representatives on Jan. 2. The Citizens Road Committee of Missouri, of which Robert B. Brooks is consulting engineer, appeared before the committee in opposition to the increase and its diversion for other than road purposes.

D. C. Henny Heads Commission to Advise on Bonneville Dam

D. C. Henny, consulting engineer, Portland, Ore., was elected chairman of the Bonneville Dam Commission at its organization meeting held in Portland on Dec. 28. A. M. Smith, Portland, is vice-chairman and Representative John Lewis, secretary. The board has asked the appointment of technical men from the Civil Works Administration to made a study of power markets. Also, it proposes to ask the government to allocate half the cost of the project, estimated at $44,000,000, to navigation in order to keep down the cost of power.

Three Million Dollars Provided For Subsistence Homesteads

The Post Office Department has been allotted $525,000 for the construction and equipment of a manufacturing plant at Reedsville, W. Va., in connection with the Reedsville Subsistence Homestead project. The plant will manufacture lock boxes, furniture and other equipment for the Post Office Department.

Secretary Harold L. Ickes has announced plans for establishment of a subsistence homestead project in Jasper at Putnam County, Ga., for which the Federal Subsistence Homestead Corporation will loan $1,000,000 to the Chancellorsville Homesteads, Inc., a corporation organized to develop and manage the project as an integral part of the program of research, teaching and extension directed by the Regents of the University System of Georgia. Other homestead projects announced are one of the Mahoning Homestead Gardens, Inc., Youngstown, Ohio, which will receive a loan of $500,000 for a number of scattered homesteads for white-collar workers in the Youngstown area, and another to be established in Pender County, N. C., by Penderlea Homestead Gardens, Inc., which will receive a loan of $1,000,000.

The PWA has allotted $25,000,000 to start execution of the government's program for the removal of sub-marginal land from commercial crop production.

WORK ON WHEELER DAM PROCEEDING RAPIDLY

Completion of the cofferdam enclosing the site of the power-house substructure of the Wheeler Dam project of the Tennessee Valley Authority, 16 miles upstream from the Wilson Dam at Muscle Shoals, will soon permit the unwatering of this first section of that project.

The accompanying photograph, made near the end of December, a few weeks after the TVA had received an executive order from President Roosevelt to proceed with this $22,000,000 undertaking, gives an idea of the width of the Tennessee River at the site. Faintly in the distance may be seen the lock of this project against the north bank. The entire structure will be nearly 6,600 ft. in length, with a spillway having a crest 50 ft. above slack water at the site from the Wilson Dam.

Limestone underlies the entire width of the stream, and extends back into both banks. Preliminary borings indicate satisfactory foundation conditions. Excavation at the lock disclosed tough, uniform material.

TVA has made unusually good progress in getting this job under way. All the floating plant and equipment needed for the construction of the cofferdam was available on the Tennessee River from the Corps of Engineers, U. S. A.

Although the final design of the substructure of the power house had not been determined when work on the cofferdam began, the engineers were able to locate the position of the upstream leg. By the time the latter was done, the outer leg could be placed and then the downstream leg could be located within narrow limits. The extensive quantities of rock that will have to be removed in preparing the site of the draft tubes and tail race will be excavated by means of large electric power shovels.

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

LIST NO. 32

LOCALITY	LOAN AND GRANT OR GRANT	TYPE	MAN-MONTHS WORK PROVIDED	AMOUNT
Readsboro, Vt.	L. & G.	School	120	$30,000
Shelby, Mont.	L. & G.	Courthouse	270	75,000
Plainfield, N. J.	L. & G.	Sewers	228	39,000
Plainfield, N. J.	L. & G.	Streets	400	71,000
Plainfield, N. J.	L. & G.	Sewers	60	11,000
Downey, Idaho	L. & G.	Water Mains	100	32,000
Plainfield, N. J.	L. & G.	Streets	224	43,000
Plainfield, N. J.	L. & G.	Sewers	360	62,000
Plainfield, N. J.	L. & G.	Streets	192	36,000
Riverton, N. J.	L. & G.	Roads	144	70,000
Lake County, S. D.	L. & G.	Courthouse	480	105,345
Sioux Falls, S. D.	L. & G.	Sewers	200	31,000
Brookings, S. D.	L. & G.	Waterworks	192	54,000
Burlington County, N. J.	G.	Bridge	600	50,000
Hughes County, S. D.	L. & G.	Courthouse	462	72,000
Scribner, Neb.	L. & G.	Water Mains	60	15,000
Newport News, Va.	L. & G.	Waterworks	200	197,000
Montclair, N. J.	L. & G.	Sewers	160	40,000
Frostburg, Md.	L. & G.	Dam	510	76,000
Louisville, Colo.	L. & G.	Waterworks	84	30,000
Teachers College, East Radford Va.	L. & G.	Dining Hall	400	135,000
Boulder, Colo.	G.	Pipe Line	100	17,000
Burlington, Vt.	G.	Building	20	1,000
Marion Junction, S. D.	L. & G.	Sewerage	120	24,000
Miles City, Mont.	G.	Waterworks	88	3,900
State of Neb.	G.	Buildings	357	23,100
Snohomish County, Wash.	G.	Road	20	1,050
Lewis County, Wash.	G.	Bridge	24	1,000
Snohomish County, Wash.	G.	Road	54	2,400
University of Washington	G.	Buildings	1,105	108,300
Cambridge, Md.	L. & G.	Sewerage	1,300	260,000
State of New Jersey, Leesburg	L. & G.	Building	120	45,000
State of New Jersey, Amandale	L. & G.	Ward Bldg.	256	101,600
State of New Jersey, Vineland	L. & G.	Building	208	79,000
State of New Jersey, Jamesburg	L. & G.	Hospital	160	71,000
State of New Jersey, Marlboro	L. & G.	Ward Bldg.	1,000	300,000
Bethlehem, N. H.	L. & G.	Sidewalks	100	17,500
Glenwood Springs, Colo.	G.	Water Main	120	5,900
Mitchell, S. D.	L. & G.	Waterworks	300	43,000
Alexandria, Va.	L. & G.	Streets	480	100,000
Bethlehem, N. H.	L. & G.	Water Mains	240	45,000
Sandpoint, Idaho	G.	Bridge	50	3,000
Bethlehem, N. H.	L. & G.	Sewer	60	8,000
Phoenix, Ariz.	L. & G.	Waterworks	1,280	250,000
State of New Jersey, New Lisbon	L. & G.	Hospital	160	47,000
State of New Jersey, Woodbine	L. & G.	Building	240	85,000
Seattle, Wash.	G.	Parks	275	15,000
State of New Jersey, Annandale	L. & G.	Building	350	128,000
Univ. of New Mexico	G.	Stadium	105	9,000
Tulsa County, Okla.	L. & G.	School	60	26,000
Parker, S. D.	L. & G.	Waterworks	60	15,000
Westfield, N. J.	L. & G.	School	1,020	275,000
Snohomish County, Wash.	G.	Roads	75	7,000
Renton, Wash.	G.	School	60	4,000
Olympia, Wash.	G.	Pumping Station	20	2,000
King County, Wash.	G.	Road	150	10,000
Olympia, Wash.	G.	Water Mains	75	4,000
Hardwick, Vt.	L. & G.	Water Mains	300	66,000
Cook, Neb.	G.	Streets	18	1,000
Pullman, Wash.	G.	School	140	14,000
Idaho Falls, Idaho	G.	Sewer Tunnel	240	10,000
Sioux Falls, S. D.	L. & G.	Sewerage	800	210,000
Grand Forks, N. D.	L. & G.	Sewerage	1,760	305,000
Custer County, Okla.	L. & G.	School	360	102,000
Keene, N. H.	L. & G.	Sewerage	910	170,000
Keene, N. H.	L. & G.	Water Mains	168	28,000
Emporia, Va.	G.	Schools	240	18,000
State of Oklahoma	G.	Schools	38	4,000
Cordell, Okla.	G.	Waterworks	60	3,000
Wahkiakum County, Wash.	G.	Highway	15	1,000
State of Virginia	G.	Art Museum	910	66,000
State of Washington	G.	Twanoh Park	48	4,000
Franklin County, Wash.	G.	Highway	46	2,000
Enumclaw, Wash.	G.	Water and Sewers	60	4,000
Tolt, Wash.	G.	School	175	12,000
Wahkiakum County, Wash.	G.	Highway	40	3,000
Wahkiakum County, Wash.	G.	Highway	65	2,000
State of Washington	G.	Road	140	8,200
Duval County, Florida	G.	Bridges	60	3,000
		Total	22,260	$4,508,295

LIST NO. 33

LOCALITY	LOAN AND GRANT OR GRANT	TYPE	MAN-MONTHS WORK PROVIDED	AMOUNT
Tarentum, Pa.	L. & G.	Waterworks	360	$75,000
Graham, Texas	L. & G.	School	290	91,000
Girard, Pa.	L. & G.	Sewerage	120	21,000
Richmond, R. I.	L. & G.	School	175	75,000
Lawrence, Kan.	L. & G.	School	300	110,000
East Providence, R. I.	L. & G.	Waterworks	1,440	245,000
Morganville, Kan.	L. & G.	Waterworks	75	24,000
Niagara Falls, N. Y.	L. & G.	Waterworks	2,520	445,000
West Milwaukee, Wis.	L. & G.	Sewers	30	10,000
Rensselaer, N. Y.	L. & G.	Sewers	135	19,000
Mexico, Mo.	L. & G.	Sewerage	192	95,000
Lake View, Iowa	L. & G.	Building	75	24,100
Nashua, N. H.	L. & G.	Sewerage	1,350	188,000
Derby, Conn.	G.	Sewers	120	5,000
Au Sable Forks, N. Y.	L. & G.	School	960	234,000
Stillwater, Okla.	G.	Water Tank	40	5,000
Meridian, Texas	L. & G.	Sewerage	195	23,000
Waldron, Ark.	L. & G.	Courthouse	200	60,000
Littleton, N. H.	L. & G.	Streets	320	82,000
Houston County, Texas	G.	School	60	6,000
Fort Worth, Texas	L. & G.	Viaduct	800	123,000
Littleton, N. H.	L. & G.	Waterworks	200	29,000
Haverhill, Mass.	L. & G.	School	500	260,000
Littleton, N. H.	L. & G.	Landscaping	220	22,000
St. Louis County, Mo.	L. & G.	Schools	720	328,000
Littleton, N. H.	L. & G.	Sewers	300	42,000
McPherson, Kan.	G.	Street Lighting	50	7,000
Marion County, Kan.	G.	Roads	36	1,000
Pratt, Kan.	G.	Streets	55	3,000
Hilo, Hawaii	L. & G.	Sewers	2,120	375,000
Marion County, Kan.	G.	County Road	36	1,000
Center Point, Iowa	L. & G.	School	75	17,000
Killdeer, N. D.	L. & G.	Waterworks	160	30,000
Van Buren, Ark.	L. & G.	School	300	87,000
Watervliet, N. Y.	L. & G.	Waterworks	800	215,000
Memphis, Tenn.	L. & G.	Drainage	220	32,000
Jasper, Ind.	L. & G.	Waterworks	120	29,000
Dickinson, N. D.	L. & G.	School	450	154,000
Van Buren County, Ark.	L. & G.	Courthouse	120	30,000
Waltham, Mass.	L. & G.	Waterworks	510	98,000
Enfield, Conn.	L. & G.	School	99	30,000
Sangamon County, Ill.	G.	Streets	780	37,000
Oxford, Ohio	L. & G.	Sewers	350	60,000
Liberty Hill, Texas	G.	School	6	500
Claymont, Del.	G.	School	300	27,000
Glendale, Ohio	L. & G.	Sewers	200	60,000
Lincoln County, Wash.	G.	Roads	165	6,000
King County, Wash.	G.	Roads	120	7,000
Jefferson County, Wash.	G.	Roads	120	16,000
State of Washington	G.	Highway	80	8,000
		Total	18,969	$3,971,600

LIST NO. 34

LOCALITY	LOAN AND GRANT OR GRANT	TYPE	MAN-MONTHS WORK PROVIDED	AMOUNT
Chino Valley Irr. Dist., Ariz.	L. & G.	Dams and Canal	195	100,000
Santa Clara, Utah	G.	Water Mains	10	2,000
Morgan, Utah	L. & G.	Schools	315	94,620
Trenton, Neb.	L. & G.	Sewerage	360	47,600
Welsh, La.	G.	Paving	130	4,500
McCook County, S. D.	L. & G.	Courthouse	240	116,000
Columbus, Ohio	L. & G.	Sewers	10,773	1,773,000
Shelton, Wash.	L. & G.	Sewerage	200	30,000
Max, N. D.	L. & G.	Building	10	3,500
Dayton, Texas	L. & G.	Sewerage	240	38,000
Huntington, Ind.	L. & G.	Sewerage	436	95,000
Pataskala, Ohio	L. & G.	Waterworks	192	36,000
Hackettstown, N. J.	L. & G.	Dam	220	62,000
Athens, Ohio	L. & G.	Waterworks	252	50,000
Crawford, Neb.	G.	Water Intake	40	2,550
Albany, N. Y.	G.	Building	637	25,200
Townsend, Mass.	L. & G.	Waterworks	1,200	154,000
Eggleston, Va.	G.	School	162	14,000
Fairfax County, Va.	G.	Schools	511	43,000
Accomack County, Va.	G.	School	260	20,200
Hillsboro, Ohio	L. & G.	School	480	175,000
New Philadelphia, Ohio	L. & G.	Waterworks	228	55,000
Univ. of Virginia, Charlottesville	L. & G.	Buildings	1,440	379,000
State of New Mexico, Las Vegas	G.	Buildings	160	28,000
Maneta, Va.	G.	School	125	9,000
Rockaway, N. J.	L. & G.	Sewer	2,770	196,000
State of Washington	G.	Trestle	105	8,000
Neosho, Mo.	L. & G.	Sewerage	175	41,000
Beaverdam, Ohio	L. & G.	Schools	175	58,000
Siloam Springs, Ark.	L. & G.	Sewerage	150	30,000
New York, N. Y.	L. & G.	School	5,040	2,500,000
Ashville, Ohio	L. & G.	Waterworks	270	60,000
Albion, Neb.	G.	Waterworks	24	2,000
Allenstown, N. H.	L. & G.	Library	40	12,000
Epping, N. H.	L. & G.	Fire House	33	9,000
Spiceland, Ind.	L. & G.	Waterworks	250	45,000
Clarence, Mo.	L. & G.	Waterworks	506	95,000
Pearisburg, Va.	L. & G.	Waterworks	150	25,000
Bellevue, Wash.	G.	School	52	4,000
Albuquerque, N. M.	G.	Sewerage	92	3,000
State of Washington	G.	Roads	210	9,000
Swarthmore, Pa.	L. & G.	School	275	90,000
Concord, N. H.	L. & G.	Sewers	25	5,000
Muleshoe, Texas	L. & G.	Waterworks	43	8,000
Brackettsville, Texas	L. & G.	Waterworks	105	26,000
Worcester, Mass.	L. & G.	Streets	3,600	643,000
Mt. Sterling, Ohio	L. & G.	Waterworks	51	12,000
Marine, Ill.	L. & G.	Streets	60	13,000
Catskill, N. Y.	L. & G.	School	1,460	365,000
Gloversville, N. Y.	L. & G.	Waterworks	1,170	261,000
		Total	35,646	$7,876,570

LIST NO. 35

LOCALITY	LOAN AND GRANT OR GRANT	TYPE	MAN-MONTHS WORK PROVIDED	AMOUNT
Tomah, Wisconsin	L. & G.	Streets	88	82,667
San Francisco, Calif. (amended)	L. & G.	Waterworks	43,200	12,095,000
San Francisco, Calif. (amended)	L. & G.	Sewerage	12,000	2,625,000
Corvallis, Ore.	L. & G.	School	990	307,750
Cedartown, Ga.	L. & G.	School	40	11,500
St. Claire County, Ill.	L. & G.	Park	5,400	1,159,000
Grantsville, Md.	L. & G.	Waterworks	160	33,000
Delano, Calif.	L. & G.	School	126	60,000
Orange County, Calif.	L. & G.	Harbor Work	2,760	918,000
Bell, Calif.	L. & G.	Building and Park	240	85,000
Pawnee, Okla.	L. & G.	Power Plant	45	60,000
Pawnee, Okla.	L. & G.	Swimming Pool	30	3,420
Parkland, Wis.	L. & G.	Hospital	350	126,000
Helena, Mont.	L. & G.	School	1,064	510,000
Miles City, Mont.	L. & G.	School	330	77,000
Tuscaloosa, Ala.	L. & G.	School	325	155,000
Long Beach, Calif.	L. & G.	Park Work	75	15,000
Utah County, Utah	L. & G.	Schools	240	56,000
State of New Jersey, Greystone	L. & G.	Hospital	1,032	359,000
Pearl River County, Miss.	L. & G.	School	63	15,000
Smyrna, Del.	G.	Schools	1,000	73,000
Carlisle, Ohio	L. & G.	Waterworks	60	13,000
St. Louis County, Mo.	L. & G.	School	315	122,000
Moorefield, W. Va.	L. & G.	Waterworks	240	50,000
Southern Pines, N. C.	L. & G.	Waterworks	100	42,000
Shelby, N. C.	L. & G.	School	36	11,000
Saranac Lake, N. Y.	L. & G.	Waterworks	75	16,000
Elizabeth City County, Va.	G.	School	230	16,000
Oconto, Neb.	L. & G.	Waterworks System	78	12,000

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

LOCALITY	LOAN AND GRANT OR GRANT	TYPE	MAN-MONTHS WORK PROVIDED	AMOUNT
Northampton, Penn.	L. & G.	Streets	690	110,700
Galveston, Texas	L. & G.	School	630	200,000
Canyon, Texas	L. & G.	Waterworks	40	9,000
State of California, Whittier	G.	Building	125	11,000
Huntsville, Texas	L. & G.	Jail	80	26,000
Minden, Neb.	G.	Power Plant	52	8,000
State of Washington, Walla Walla	G.	Penitentiary	180	16,000
Wahkiakum County, Wash.	G.	Roads	36	3,000
King County, Wash.	G.	School	90	8,000
Cottonwood Falls, Kan.	L. & G.	Waterworks	10	4,000
Des Arc, Ark.	L. & G.	Sewerage	174	29,000
Plandome, N. Y.	L. & G.	Waterworks	210	70,000
Muncie, Ind.	L. & G.	Sewerage	3,600	1,060,000
Plattsburgh, N. Y.	G.	Water Mains	62	6,000
Newton, Mass.	L. & G.	Sewers	640	115,000
Concord, N. H.	L. & G.	Sewers	390	53,000
Concord, N. H.	L. & G.	Sewers	400	54,000
Blooming Prairie, Minn.	L. & G.	Waterworks	60	14,000
Kahoka, Mo.	L. & G.	Waterworks	60	35,000
Beaver, Neb.	L. & G.	Ice Equipment	8	8,000
Kent County, Del.	G.	School	227	19,000
Whittier, Calif.	G.	Waterworks	48	4,000
Concord, N. H.	L. & G.	Fire Station	60	20,000
Bandom, Ore.	G.	Gymnasium	30	3,000
Lewis County, Wash.	G.	Roads	250	17,000
King County, Wash.	G.	Roads	111	6,000
Clark County, Wash.	G.	Roads	90	6,000
Los Angeles, Calif.	G.	Streets	5,000	304,000
		Total	84,054	$21,327,037

LIST NO. 36

Laguna Beach, Calif.	L. & G.	Sewerage	660	190,000
Shenandoah Co., Va. (Amended)	G.	School	480	16,000
Bovey, Minn.	G.	Village Hall	210	16,000
Lifton, Ind.	L. & G.	Gas Mains	400	75,000
Salt Lake City, Utah	L. & G.	Schools	1,800	626,500
Osakis, Minn.	L. & G.	Water Mains	90	12,000
Paw Paw, Mich.	L. & G.	Sewerage	140	29,000
Whatcom County, Wash.	G.	Streets	60	2,000
North Sacramento, Calif.	L. & G.	School	728	164,000
Fayetteville, N. C.	L. & G.	Water Meters	60	20,000
Watertown, S. D.	L. & G.	Streets	750	109,000
Jefferson County, Kan.	L. & G.	Roads	240	38,000
Jefferson County, Kan.	L. & G.	Roads	350	47,800
State of Massachusetts	L. & G.	Highways	225	47,000
Gilmer, Texas	L. & G.	Sewerage	70	10,000
Jefferson County, Kan.	L. & G.	Roads	825	108,000
Albia, Iowa	L. & G.	School	90	28,300
Libby, Mont.	L. & G.	Building	60	16,000
Varina, Va.	G.	School	51	4,000
York County, Va.	G.	Schools	60	4,000
Shafter, Calif.	L. & G.	School	210	81,000
Ashville, Ohio	L. & G.	Sewerage	300	40,000
Maui County, Hawaii	L. & G.	Sewers	1,120	223,000
Houston, Del.	L.	Fire House	32	5,000
Juneau, Alaska	L.	Water Mains	20	5,000
Bonner Springs, Kan.	L. & G.	School	300	54,000
Greenburgh, N. Y.	L. & G.	School	2,400	800,000
Macon County, Mo.	L. & G.	School	30	9,000
Glens Falls, N. Y.	L. & G.	Streets	440	108,000
North Hempstead, N. Y.	L. & G.	School	1,030	350,000
Rockmart, Ga.	L. & G.	Sewer	76	10,000
Almond, N. Y.	L. & G.	Waterworks	120	34,000
Santa Barbara County, Cal.	G.	Sewers	10	1,000
Polk, Neb.	L. & G.	Waterworks	60	16,000
Polk County, Mo.	L. & G.	School	102	44,000
Brookfield, Mo.	L. & G.	Sewerage	320	59,000
Gatesville, Texas	L. & G.	Building	100	32,000
Memphis, Tenn.	L. & G.	Fire Tower	24	9,000
Colorado County, Texas	L. & G.	Drainage	495	65,000
Sacramento, Calif.	G.	City Hall	180	17,000
Clay County, Kan.	G.	Road	24	3,000
Clarence, Mo.	L. & G.	Sewerage	385	48,000
Columbia City, Ind.	G.	Municipal Power	270	29,000
King County, Wash.	G.	Bridge	180	15,000
State of Indiana, Muncie	G.	School	1,020	95,000
Garfield County, Wash.	G.	Road	40	2,000
Clark County, Wash.	G.	Road	82	7,000
Snohomish County, Wash.	G.	Road	138	8,000
Snohomish County, Wash.	G.	Bridge	100	11,000
State of Nebraska, Norfolk	G.	Hospital	100	8,000
State of Nebraska, Lincoln	G.	Hospital Add.	100	9,000
State of Texas, San Antonio	G.	Building	36	4,000
Clay County, Kan.	G.	Highway	16	1,000
		Total	17,209	$3,764,800

LIST NO. 37

Los Angeles, Calif.	L. & G.	Parker Dam	7,200	2,000,000
Georgetown County, S. C.	L. & G.	Toll Bridge	5,600	760,000
Greenbay, Wis. (amended)	L. & G.	Sewerage	3,360	135,000
Russellville, Ark.	L. & G.	Buildings	500	135,000
St. Francis Levee Dist., Ark.	L. & G.	Levee	62,550	552,000
Atlantic Beach, Fla.	L. & G.	Sea Wall	750	168,000
Teachers College, Conway, Ark.	L. & G.	Dormitory	402	136,000
Agricultural College, Monticello, Ark.	L. & G.	Buildings	390	96,000
University of Arkansas	L. & G.	Building	1,000	500,000
Chamberlain, S. D.	L. & G.	Waterworks	100	33,000
West Kittanning, Pa.	L. & G.	Waterworks	160	58,000
Scottsbluff, Neb.	L. & G.	Streets	240	65,900
Drain, Ore.	L. & G.	Waterworks	81	21,000
Turlock Irr. Dist., Calif.	L. & G.	Canals	2,000	311,000
Univ. of North Carolina	L. & G.	Stadium	50	14,000
Hagerstown, Md.	L. & G.	Hospital	900	407,000
Gulfport, Miss.	L. & G.	Warehouse	4,380	1,150,000
Ely, Minn.	L. & G.	Waterworks	350	74,000
Centralia, Wash.	L. & G.	Pipe Line	450	80,000
Snohomish, Wash.	L. & G.	Water Mains	1,200	147,000
Okanogan, Wash.	L. & G.	Water Mains	74	8,000
Chehalis, Wash.	L. & G.	Water Mains	500	143,000
Erie, Colo.	L. & G.	Water Mains	60	29,000
Mountain Home, Idaho	L. & G.	Water Mains	162	54,000
Clark, S. D.	L. & G.	Courthouse	400	146,000
Blacksburg, Va.	L. & G.	Waterworks	4,620	1,066,000
Houma, La.	L. & G.	Incinerator	50	18,000
Cape Girardeau, Mo.	L. & G.	Schools	456	156,000
Moberly, Mo.	L. & G.	Municipal Power	720	200,000
Kirksville, Mo.	L. & G.	Sewers	675	216,000
McPherson, Kan.	L. & G.	Sewers	200	29,000
Moab, Utah	L. & G.	Waterworks	265	47,000
Alexandria, La.	L. & G.	Municipal Power	840	250,000
Toppenish, Wash.	G.	School	220	12,000
Aberdeen, S. D.	L. & G.	Sewerage	840	152,000
Albion, Pa.	L. & G.	Sewerage	390	64,000
Passaic, N. J.	L. & G.	Schools	350	96,000
Augusta Canal Commission, Ga.	L. & G.	Hydro-Elec. Plant	2,700	1,250,000
East Bank, W. Va.	L. & G.	Water Mains	80	16,000
Water Power and Control Comm., Albany, N. Y.	L. & G.	Sewage	45	11,000
Carthage, S. D.	L. & G.	Drainage Ch'ls.	700	106,000
Donna Irrigation Dist., Texas	L. & G.	Canal Lining	3,000	490,000
Rockville, Minn.	L. & G.	Water and Sewers	100	25,000
Louisville, Neb.	L. & G.	Waterworks	45	9,000
Faulkton, S. D.	L. & G.	Jail	120	43,000
Alcester, S. D.	L. & G.	Waterworks	60	16,700
Teachers College, Arkadelphia, Ark.	L. & G.	Buildings	160	50,000
Mauch Chunk, Pa.	L. & G.	Streets	105	25,000
Arlington Heights, Ill.	L. & G.	Waterworks	200	50,000
McPherson, Kan.	L. & G.	Buildings	270	100,000
Greenleaf, Kan.	L. & G.	School	105	25,000
Orange County, Calif.	L. & G.	Sewer	150	24,000
Winona, Minn.	L. & G.	Sewerage	1,500	270,000
Great Bend, Kan.	L. & G.	Swimming Pool	100	36,000
McConnellsville, Ohio	L. & G.	School	280	67,000
Olive View, Calif.	L. & G.	Hospital	1,740	532,000
Sacramento, Calif.	G.	Fire House	64	3,000
		Total	113,907	$13,157,600

LIST NO. 38

Stockton, Calif.	L. & G.	Warehouse	900	230,000
Hueneme (Calif.) Dock Corp. (Private)	L.	Harbor Work	10,500	1,600,000
Fulton, Mo.	L. & G.	Sewerage	240	70,000
Wichita, Kan.	L. & G.	Park Work	200	66,000
Yankton, S. D.	L. & G.	Streets	50	11,700
Tipton, Ind.	L. & G.	Municipal Power	280	170,000
Cedar Rapids, Iowa	L. & G.	Water Mains	790	140,000
Denver, Colo.	L. & G.	Waterworks	4,200	950,000
Hot Springs, S. D.	L. & G.	Sewerage	240	47,000
Racine, Wis.	L. & G.	Sewerage	3,825	756,000
Phoenix, Ariz.	L. & G.	Sewers	3,120	420,000
Phoenix, Ariz.	L. & G.	Sewers	1,380	315,000
Santa Paula, Calif.	L. & G.	Police Station	44	13,000
Whatcom County, Wash.	G.	Bridge	50	6,000
Linn, Kan.	L. & G.	Waterworks	150	28,000
Los Angeles, Calif.	L. & G.	Harbor Work	1,350	342,000
Concordia, Mo.	L. & G.	Municipal Power	120	47,000
Burkesville, Ky.	L. & G.	Waterworks	200	48,000
Hutchinson, Kan.	L. & G.	Buildings	180	77,000
Oceanside, Calif.	L. & G.	City Hall	140	36,000
California, Mo.	L. & G.	Municipal Power	180	155,000
Philip, S. D.	L. & G.	Waterworks	54	10,000
Hawthorne, Calif.	L. & G.	Sewers	1,440	226,000
Broadway, Va.	L. & G.	Waterworks	160	42,000
Charlevoix, Mich.	L. & G.	Sewerage	320	87,000
Delphi, Ind.	L. & G.	Waterworks	90	20,000
Round Rock, Texas	L. & G.	Waterworks	160	40,000
Sacramento County, Calif.	L. & G.	Hospital	240	49,000
Fort Stockton, Texas	L. & G.	Sewerage	280	60,000
Kiel, Wis.	L. & G.	Sewers	150	40,000
Naches, Wash.	L. & G.	Irrigation	75	6,000
Morris Plains, N. J.	L. & G.	Sewer	150	32,000
Gloucester, Mass.	L. & G.	Water Mains	800	100,000
Scottsburg, Ind.	L. & G.	Waterworks	87	16,000
Sioux Center, Iowa	L. & G.	Waterworks	180	31,000
Amherst, Va.	L. & G.	Waterworks	105	25,000
Union, Neb.	L. & G.	Street	60	14,000
Gilroy, Calif.	L. & G.	Water Mains	90	37,000
Santa Clara County, Calif.	L. & G.	Building	192	56,000
New York, N. Y.	L. & G.	Hospital	1,222	800,000
Rochester, N. Y.	L. & G.	Bridge	2,100	515,000
Huntington, N. Y.	L. & G.	School	2,100	550,000
Winchester, Ill.	L. & G.	Waterworks	90	28,000
Stanton, Ky.	L. & G.	Waterworks	80	24,000
Glens Falls, N. Y.	L. & G.	Water Mains	360	83,000
Rockmart, Ga.	L. & G.	Waterworks	40	14,000
Cameron County Water Dist., Texas	L. & G.	Irrigation	4,800	404,000
Georgetown, Texas	L. & G.	Waterworks	210	36,000
Sonora, Texas	L. & G.	City Hall	18	6,000
Siskiyou Co., Calif.	G.	School	54	4,000
Colton, Calif.	L. & G.	Waterworks	300	93,000
Boston, Mass.	L. & G.	Water Mains	1,600	350,000
Boston, Mass.	L. & G.	Schools	7,200	2,000,000
Snohomish County, Wash.	G.	Roads	36	3,000
Lincoln County, Wash.	G.	Roads	123	6,000
Lincoln County, Wash.	G.	Roads	156	7,000
Thurston County, Wash.	G.	Roads	126	8,000
Thurston County, Wash.	G.	Roads	36	3,000
Snohomish County, Wash.	G.	Roads	36	3,000
Davenport, Iowa	G.	Streets	288	20,000
Los Angeles, Calif.	G.	School	250	13,000
Los Angeles, Calif.	G.	School	240	12,000
		Total	54,587	$11,400,700
		Grand Total	**346,632**	**$66,006,402**

Colorado Highway Aid Plan Declared Unconstitutional

The supreme court of the state of Colorado has declared unconstitutional the proposal made recently to issue debentures to be turned over to the Public Works Administration as security for a loan of $10,000,000 for highway construction. The court held that the constitution required that such a proposal be put to popular vote and that the constitution could not be set aside on the claim that an emergency existed.

Rhode Island Sewerage Project Attacked by State Water Board

Characterizing the Rhode Island Metropolitan Sewer Commission's $19,640,000 unified disposal program (*ENR* Dec. 28, 1933, p. 795) as fantastic, unnecessary and capable of doubling the entire state debt, the state board for purification of waters has issued a report on the project stressing the cost of such an undertaking and asserting that it would not solve the problem of stream pollution in the Narragansett Bay area. The report was signed by Dr. Thos. H. Connolly, chairman, and by Harold T. Merriman and William F. Fortin.

The report takes issue with the sewer commission's favorable comment on the benefits to the shell-fish industry expected by advocates of the unified system. It intimates that the United States Public Health Service, which certifies the areas from which shell-fish are taken for shipment in interstate commerce, will withhold from approval the areas adjacent to Prudence Island if the proposed treatment plant is established there. It states that the debt of Rhode Island will be $39,529,192 if the unified project goes through, independently of other additions by the Public Works Corporation. Municipalities, manufacturers and individuals who have already provided sewage and waste treatment facilities, the report states, have a legitimate claim for a fair reimbursement.

A fertile source of industrial damage claims is seen in the proposed transportation of industrial wastes through trunk sewers to Prudence Island from manufacturing plants on the Blackstone, Pawtuxet and other rivers which use the river waters for power and processing. Damages from such actions appear likely greatly to increase the cost of the proposed district system over the estimates.

Due consideration, the report states, has not been given to the effect of local treatment of sewage and industrial wastes. The board points out that much more is needed to cure the pollution problem in Rhode Island than to take sewage from the tributaries of the Providence River and discharge it after treatment into the lower bay from Prudence Island. "It is far from certain," says the report, "that the protection of the public health will be served by removing the sewage from the streams used solely for manufacturing purposes and discharging it into waters now unpolluted and at present used for shellfisheries, boating, bathing and other recreational purposes. . . . the gain from removing all manufacturing wastes from the rivers by the proposed district project is not commensurate with the cost."

Army Engineers Outline River Work of $30,940,000

RIVER and harbor work estimated to require an expenditure of $30,940,000 during the fiscal year ending June 30, 1935, is outlined in a statement prepared for the information of Congress by the Corps of Engineers. Additional appropriations of $25,000,000 will be required as there will remain on June 30, 1934, an unobligated balance of $5,940,000.

For rivers and harbors on the Atlantic Coast a total of $8,048,000 will be required, the largest item being over $2,000,000 for the Delaware River below Philadelphia. For the Gulf Coast, $3,550,000 will be required, about half a million each being allotted to the Southwest Pass on the Mississippi; the Sabine-Neches Waterway and the Houston Ship Channel. The Pacific Coast will require $3,205,000. In the latter are $374,000 for San Diego Harbor, $610,000 for work at the mouth of the Columbia River and $685,000 for work on the Columbia and lower Willamette rivers below Vancouver, Wash., and Portland, Ore.

Intracoastal waterways will require $1,477,000, the larger items being $300,000 for the Chesapeake-Delaware waterway, recently approved for deepening, $200,000 for work between Jacksonville and Miami and $235,000 in the Louisiana-Texas waterway.

A sum of $532,000 is asked for the waterways of the lower Mississippi system and $6,522,000 for the middle and upper system. This includes $2,500,000 on the river itself, $2,000,000 on the Missouri and $1,337,000 for open-channel work on the Ohio. It does not include the 9-ft. channel work on the Upper Mississippi being carried out with PWA funds.

For the Great Lakes system only $2,231,000 is asked, with no large items included. Work on the Detroit River, requiring $2,547,000, is included as a separate item.

Projects financed by the PWA and being carried out by the Corps of Engineers are not included in this program. Bonneville dam on the Columbia River is one of these.

San Francisco Will Rush Work As Result of PWA Loan

With the assurance of $18,480,000 of PWA financing for the public works projects voted at a special election Nov. 7, San Francisco is ready to call for bids on the projects as soon as the loan contracts with the government are signed. City officials estimate that the last work contract will have been awarded by Mar. 1 and that 3,000 men will be at work 30 days later with a peak of 6,500 by the middle of summer.

About $12,000,000 of the financing will go to improvements in the water distribution system including: a pipe line crossing across lower San Francisco Bay to increase the supply line capacity ($4,700,000), local distribution reservoirs and extensive betterments in the distribution mains; raising of O'Shaughnessy dam ($3,500,000); the other $2,600,000 will provide badly needed improvements in the sewer system and two sewage disposal plants.

Arkansas Highway Revenues Tied up by Permanent Injunctions

Highway revenues of the State of Arkansas have been tied up by a permanent injunction of a Federal Court sitting at Little Rock issued pending the settlement of refunding of the $155,000,000 highway debt on terms satisfactory to the bondholders. The injunction suit was brought to keep the state treasurer from paying out any funds derived from the gasoline tax and motor license fees except those required for highway bond payments and for maintenance work. Also, it was brought to prevent refunding of the highway bonds under the refunding act passed last year.

Capt. N. M. Smith Named Head of Bureau of Yards and Docks

Capt. Norman Murray Smith, Civil Engineer Corps, U. S. Navy, formerly public works officer at the Boston Navy Yard, has been named Chief of the Bureau of Yards and Docks of the Navy Department, Washington, D. C., with the rank of rear admiral, Civil Engineers Corps, to succeed Rear Admiral Archibald L. Parsons, whose term of office expired on Dec. 23. Rear Admiral Parsons has been chief of the bureau since December, 1929. He entered the naval service from civil life in April, 1903, having graduated from Massachusetts Institute of Technology in 1893.

Rear Admiral Smith is a native of Williston, S. C., and a graduate from the Naval Academy in the class of 1906. He was appointed assistant civil engineer of the U. S. Navy, with the rank of lieutenant, junior grade, in April, 1907. During the World War he was in charge of the construction of the naval training station at Great Lakes, Ill., and subsequently served as public works officer at the navy yard at Charleston, S. C., and at Norfolk, Va. From 1926 to 1930 he served in the Bureau of Yards and Docks in Washington.

Hetch Hetchy Coast Range Tunnel Holed Through

The last section of the 28½-mile Coast Range tunnel of the Hetch Hetchy water supply project for San Francisco was holed through Jan. 5 with a ceremony which included the presence of Mayor Rossi and high engineering officials. There now remains only the final concrete lining of the 5-mile section between the two deep shafts, where lining was held up to avoid interference with driving operations, and there is definite assurance that San Francisco will celebrate the arrival of mountain water through the Hetch Hetchy system this spring.

The driving of Coast Range tunnel was started in 1927 immediately following completion of the Foothills tunnel. The work has been carried out by force account operations using the same organization which had built other sections of the project. Driving operations have been described in ENR Jan. 15, 1931, p. 96 as they were carried on before the encountering of gaseous conditions. The modified driving procedure developed subsequently was described in ENR June 1, 1933, p. 701. Lining methods were described in ENR July 21, 1933, p. 107.

Municipal Power Construction Included In Milwaukee Budget

A budget totaling $28,600,000 in bonds for construction work during 1934, approved by the Common Council of Milwaukee, Wis., on Dec. 29, provides $15,000,000 for the construction of a power plant, $6,000,000 for housing and slum clearance, $4,600,000 for a filtration plant and $3,000,000 for miscellaneous utilities.

Before the work can go ahead, separate ordnances covering each of the projects must be approved and loans obtained from the Public Works Administration.

Chicago Sanitary District Reports to Supreme Court

Progress of the Sanitary District of Chicago in carrying out the schedule of work prescribed by the Supreme Court, as noted in the semi-annual report dated Jan. 1, 1934, has been small so far as construction is concerned but design has been prosecuted diligently. Financing of all the work that can be done in 1934 and 1935 was accomplished Dec. 16, 1933, when PWA purchased $42,000,000 of the district's bonds.

In general, the two-year program is complete in itself, i.e., sewage treatment works will not be built with capacity in excess of the sewage flow brought to them. Further, with this job done, all of the sewage of the central part of the city, including the Loop district, will be carried by intercepters down to the West Side plant so that there will be an added factor of safety when the Chicago River backs out into the lake during storms.

Plans are being prepared for the blower house, the aeration tanks, operating galleries, final settling tanks and conduits for the new West-Southwest activated-sludge plant. Specifications are practically ready for the blower units. Plans for the first two batteries of aeration and final settling tanks, with sufficient capacity to handle 500 m.g.d. average flow of sewage, are being prepared so that bids could be taken in the early spring of 1934 if it were not for the engineering survey required by the agreement with PWA. Plans and specifications for the substructure of the blower house are being prepared so that bids could also be taken in the early summer of 1934.

The financial condition of the district due to the local tax situation is essentially unchanged since the last report. Up to Dec. 18, 1933, the percentages of tax delinquencies for the year 1928, '29, '30 and '31 are 18.2, 22.3, 30.4 and 34.7 per cent respectively. The non-payment of taxes has forced defaults of $14,853,000 of principal and $2,382,000 of interest as of Dec. 20, 1933. A further default of principal and interest on Jan. 1 amounts to $982,475.

The extent of the operation of sewage treatment plants at the present time is equivalent to 100-per-cent treatment of the sewage of 1,622,000 people. This indicates the treatment of 32.0 per cent of the total sewage within the sanitary district.

The average monthly diversion from Lake Michigan for the year 1933 was 6,280 sec.-ft. The domestic pumpage of water was 1,690 sec.-ft. which with minor inflow makes the total flow down the main channel 8,015 sec.-ft.

SOCIETY CALENDAR

ASSOCIATED GENERAL CONTRACTORS, annual convention, Washington, D. C., Jan. 29-31, 1934.

AMERICAN CONCRETE INSTITUTE, Toronto, Ontario, Canada, Feb. 20-22, 1934.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill., March 13-14, 1934.

AMERICAN ROAD BUILDERS ASSOCIATION, annual convention, Chicago, Jan. 22-26, 1934.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York, Jan. 17-20, 1934.

AMERICAN SOCIETY FOR TESTING MATERIALS, Atlantic City, N. J., June 25-29, 1934.

AMERICAN TOLL BRIDGE ASSOCIATION, annual convention, Cincinnati, Ohio, Jan. 26-27, 1934.

AMERICAN WOOD PRESERVERS ASSOCIATION, Houston, Texas, Jan. 23-25, 1934.

AMERICAN WATER WORKS ASSOCIATION, annual convention, New York, June 4-8, 1934.

CANADIAN CONSTRUCTION ASSOCIATION, Toronto, Ont., Jan. 22-26, 1934.

ENGINEERING INSTITUTE OF CANADA, 48th annual general meeting, Montreal, Que., Feb. 8-9, 1934.

SMOKE PREVENTION ASSOCIATION, annual convention, June 19-22, Buffalo, N. Y.

THE EIGHTH ANNUAL HIGHWAY ENGINEERING CONFERENCE is to be held at the University of Colorado at Boulder on Jan. 18-19.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS will celebrate its 50th anniversary by special exercises and an exhibition held in connection with its annual meeting in New Haven on Feb. 20-21.

PENNSYLVANIA WATER WORKS OPERATORS ASSOCIATION will hold its annual meeting at State College, Pa., June 25-27, immediately preceding the annual meeting of the Pennsylvania Sewage Works Association.

NEW YORK STATE SEWAGE WORKS ASSOCIATION will hold its sixth annual meeting in New York on Jan. 16, immediately preceding the meeting of the American Society of Civil Engineers. The sessions will be held at the Hotel McAlpin. On Tuesday evening there will be a joint dinner with the Sanitary Engineering Section of the American Society of Civil Engineers.

Brief News

PLANS FOR THE CONSTRUCTION of a sewage treatment works at Depew, N. Y., have been approved by the State Department of Health. The city now discharges its sewage into Cayuga Creek. An application for a loan from the PWA will be made to finance the work.

WORK IS EXPECTED TO BEGIN soon on the $500,000 Santa Fe Railroad passenger station at Oklahoma City. The station is one of the final elements of the track elevation program of Oklahoma City. Contract for the construction of the station has been awarded to F. M. Spencer & Son Construction Co., Topeka. The old station, built in 1905, already has been torn down.

PROPOSAL FOR A $15,000,000 irrigation scheme for southern Saskatchewan has been laid before the Saskatchewan and the dominion governments. The proposal is for the construction of a power dam across the South Saskatchewan River, a mile north of Riverhurst, to generate 100,000 hp. to supply Regina and Moosejaw, Sask. Construction will employ 1,500 men for two or three years.

THE LOS ANGELES, Calif., county grand jury, called upon to conduct an investigation as to the quality of Colorado River water, particularly the question of whether its fluorine content is dangerously high, in an annual report rendered on Dec. 20 announced that no final conclusion had yet been reached. The investigation was carried on by the grand jury's public health and sanitation committee.

FOUR NEW SHORT COURSES, giving training in construction methods in connection with public works projects, have recently been prepared by the Extension Division of the University of Wisconsin. The four types of work covered are construction of highways, construction of sewers, construction of water supply systems, and plain concrete construction. The courses are described as of benefit to assistant foremen and foremen.

COURT ACTION to prevent Tarrant City, Ala., from carrying through its application for a loan from the Public Works Administration for the construction of a municipal light and power system has been begun by Samuel S. Hall, an employee of the Birmingham Electric Co., which furnishes light and power to the community. The suit attacks a new state law which permits towns and cities to exceed the constitutional limitation on indebtedness for self-liquidating projects of this character.

A BILL AUTHORIZING THE CONSTRUCTION of a vehicle tunnel under the Delaware River below Philadelphia has been passed by the Pennsylvania legislature and signed by the Governor. The proposed tunnel will be at least 10 miles below the Philadelphia-Camden bridge. It is sponsored by the South Philadelphia and New Jersey Tunnel Association and is estimated to cost $25,000,000. The project yet has to be approved by the New Jersey legislature and by the Delaware River Joint Commission.

IN A SPECIAL REPORT to the legislature the Massachusetts department of public utilities recently considered the possibilities of further protecting railroad grade crossings and drawbridges over waterways from accident hazards. The investigation was based on a proposed act requiring the erection of safety barriers at least 300 ft. from such crossings, specifying that such devices should be capable of resisting a blow of at least 50 tons when hurled against them at high speed. The commission found that it would be impracticable and prohibitive in cost to recommend barriers for railroad grade crossings and that no satisfactory construction appears available for drawbridge barriers of the type suggested. However, legislation is recommended providing for the erection of drawbridge barriers 75 ft. from each side of the draw opening.

Personal Notes

WILLIAM G. POWELL, an engineer of Lawrence, Mass., has been named city manager of Ashland, Ky.

THOMAS H. ALLEN, consulting engineer, Memphis, has been named state engineer for Tennessee for the Public Works Administration to succeed Harry F. Berry.

GEORGE DRISCOLL has resigned as city manager of Chillicothe, Ohio, and has been named district engineer for the CWA in Ross, Jackson and Pike counties, Ohio.

D. E. WOOZLEY has been appointed chief engineer of the Union Railroad Co., Pittsburgh, Pa. S. S. MCGREGOR has been

made engineer of track and A. L. LEE engineer of bridges.

FRANCIS H. CARROLL, senior engineer, New York state highway department, at Rochester, N. Y., has been appointed chief engineer in charge of all CWA work in Rochester and Monroe County.

HARRY A. BRINKERHOFF has been appointed city manager of South Portland, Maine. Mr. Brinkerhoff was the first city manager of Portland and left there several years ago to engage in engineering practice in New York City.

HOWARD M. PROPPER, who has recently been to the United States on a visit, has sailed for Chile to join the engineering staff of the Broden Copper Co. at Rancaqua. Mr. Propper was previously with the Chile Exploration Co.

H. D. PALMORE, city manager of Covington, Ky., for the past two years, submitted his resignation effective Dec. 31, 1933. Mr. Palmore is to become secretary of the Kentucky Contractors Association with headquarters in Frankfort.

ROSS M. RIEGEL, chief engineer of the division of bridge in the public works department of Pittsburgh, Pa., until his resignation recently, has been appointed an hydraulic engineer on the work of the Tennessee Valley Authority, Knoxville, Tenn.

Obituary

JOSEPH S. OECHSLE, a consulting engineer of the Worthington Pump and Machinery Corporation, died at the Hahnemann Hospital in Philadelphia on December 24, 1933, at the age of 39.

CLINTON S. MARSHALL, for many years district manager of the American Steel & Wire Company, with headquarters at Worcester, Mass., died on Jan. 1 at his home in North Grafton, Mass. Mr. Marshall was 73 years old.

WILLIAM H. WHEELER, assistant professor of civil engineering at Washington University, St. Louis, Mo., died at his home there on Dec. 30. Mr. Wheeler was 43 years old, a native of St. Louis and a graduate of Ohio Northern University. He joined the faculty of Washington University 14 years ago, following his return from active service in the army in France.

DANA LIBBEY, deputy street commissioner of the city of Newton, Mass., from 1903 to 1933, died on Jan. 4 at his home in that place after an illness of some weeks. He resigned his post last month. Mr. Libbey was born at Lebanon, Me., in 1867 and went to Newton in 1890, where he was connected with the city engineering department prior to his appointment in the street division.

JOHN MEIGGS EWEN, formerly supervising engineer for the architectural firm of Burnham & Root of Chicago during the early days of the development of steel frame building, and subsequently associated with George A. Fuller in the formation of the George A. Fuller Construction Co., died at Washington, D. C., on Dec. 19, age 74 years. Mr. Ewen was born at Newtown, N. Y., in 1859, and studied engineering at Stevens Institute of Technology. In 1879 he became engineer for the J. B. & J. M. Cornell Iron Works, New York, and later was on the construction of elevated railroads in New York City.

WILLIAM B. TAYLOR, consulting engineer, New York, formerly district manager for the Foundation Company at New York, died at his home in Maplewood, N. J. on Jan. 9, age 55 years. Mr. Taylor was a native of Montgomery, Ala., and a graduate of the State University of Louisiana. After graduation he was in railroad engineering work for a time and in 1916 became associated with the Foundation Company as its engineer at Buffalo. Since that time he has been with the Foundation Company continuously up until two years ago when he resigned to take up private practice, his work including the supervision of projects in this country, Canada and South America.

CONSTRUCTION STATISTICS OF THE WEEK

HIGHWAY contracts dominate the engineering construction awards which total $27,402,000 for the past week, an increase of $700,000 over the previous four-weeks average. The highway awards total $15,911,000, the highest since a similar total for the fourth week of November. Industrial buildings also were higher than during the preceding week, swelled by the award of a steel strip mill in Yorkville, Ohio.

Federal awards dropped 55 per cent from last week to a total of $4,413,000, while state and municipal increased from $15,094,000 to $18,197,000. Private awards almost doubled the previous week's total, coming up from $2,546,000 to $4,802,000.

Large awards for the week include: Twin locks No. 26 at Alton, Ill., on the Mississippi; road awards in Missouri totalling $2,999,000, in Tennessee totalling $1,000,825, and in New York, $2,012,591; elevated highway in New York City, $1,051,000; and apartments in Philadelphia, $950,000.

PWA allotments for state and municipal work reached a new high, totalling $122,650,000, and allotments for private work dropped to $3,335,000. Total new capital for the week, exclusive of allotments for federal work, is $126,798,000. PWA news for the week also includes rescinded or reduced allotments (affecting 1933 totals) of $35,908,000.

CONTRACTS

(Thousands of Dollars)

	Weekly Average Jan. 1933	Prev. 4 Weeks	Week Jan. 11, 1934
Federal Government	**$3,636**	**$6,239**	**$4,413**
State and municipal	15,810	12,924	18,197
Total public	$19,446	$19,164	$22,610
Total private	4,402	7,560	4,802
Week's total	$23,848	$26,724	$27,412
Cumulative to date: 1933 $65,610		1934 $55,000	

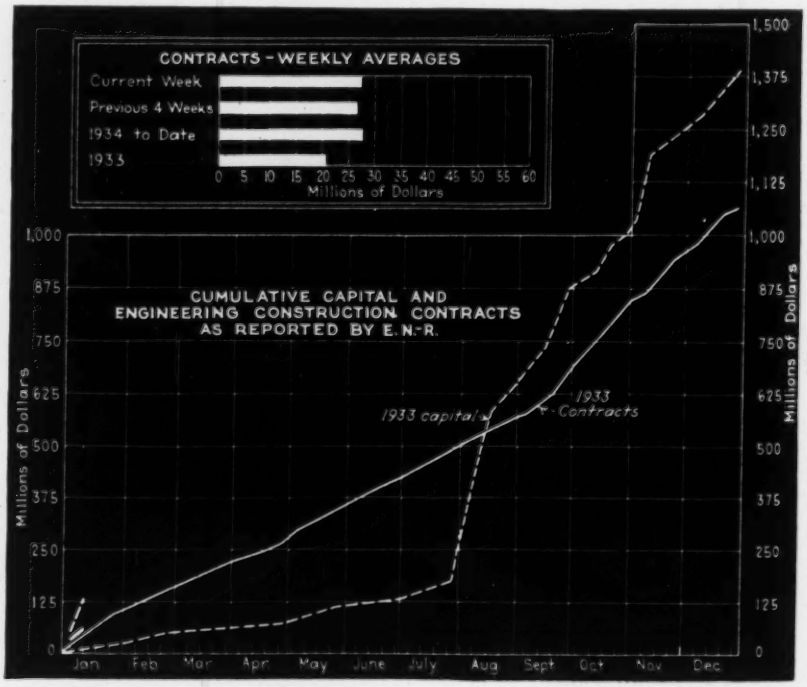
NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

1934	Week Jan. 11	Cumulative
State and municipal	$813	$5,765
PWA allotments, S&M	122,650	141,913
Corporate issues	.....	.....
PWA allotments, private	3,335	30,879
Total, Non-Federal	$126,798	$178,557
PWA allotments Federal Const.	7,110	43,866
Total new capital	$133,908	$222,423
Cumulative Total to date: 1933 $15,550	1934	$178,557
Rescinded or reduced allotments (from 1933 PWA totals)		$35,908

INDEX NUMBERS

E.N.-R.-Cost		E.N.-R.-Volume	
January, 1934	**191.26**	**December, 1933**	**116**
December, 1933	192.14	November, 1933	133
January, 1932	158.44	December, 1932	113
1933 (Average)	170.28	1933 (Average)	102
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1913 (Average)	100		


CONTRACTS - WEEKLY AVERAGES
Current Week
Previous 4 Weeks
1934 to Date
1933
0 5 10 15 20 25 30 35 40 45 50 55 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1933 capital
1933 Contracts
Millions of Dollars
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
0 125 250 375 500 625 750 875 1,000 1,125 1,250 1,375 1,500